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Rethinking stock market integration: Globalization, valuation and convergence*

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Abstract

This paper aims to study the extent of integration among developed and emerging stock markets in the onset of globalization through the formulation of a unified conceptual framework that synthesizes the stock valuation model and the convergence hypothesis. Market integration manifests in the convergence of stock valuation ratios of markets in the long run, where valuation ratios are reflective of stock fundamentals driven by common global factors across markets. The spectrum of transition dynamics of markets towards integration is explored with variants of valuation ratios and different notions of convergence. Results reveal the time-varying nature of the global stock market integration process that is characterized by heterogeneous transition experience of markets at both the total market and disaggregated industrial sector levels.

JEL classification: F36, G12, G15
Keywords: Convergence, Stock market integration, Valuation ratio

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1. Introduction

As the world is undergoing the rapid process of globalization, international trade in both goods and financial assets have expanded tremendously. Fast development in information technology and means of communications have greatly facilitated the international transmission of information, dissemination of knowledge and diffusion of technology. The financial markets are characterized by dramatic evolutions, with liberalization of financial transactions, removal of restrictions on cross-border capital flows, development of new financial products, as well as harmonization of practices, policies, regulations and corporate governance rules. A key question then arises is whether global stock markets have become more integrated (Beine et al., 2010; Masih and Masih, 1999), which has been referred to as the globalization of stock markets (Davis and Marquis, 2005; Masih and Masih, 2002). This issue has become a core subject of econometric concern due to some significant implications. Market integration promotes international risk diversification, enhances efficient allocation of capital, lowers the cost of capital, stimulates investment flows, and thus spurs real economic growth (Arouri et al., 2010; Baele et al., 2004; Bekaert et al., 2005). More integrated markets, by virtue of broadening the investor base, also improves the accuracy of public information and reduces volatility (Umutlu et al., 2010). However, a greater extent of market integration leads to more similar risk-return characteristics across markets (Eun and Lee, 2010a), and erodes gains from international portfolio diversification for financial risk reduction. Moreover, intensified linkages in extreme market realizations harbor cross-border contagion and threaten global financial stability (Morana and Beltratti, 2008). International propagation of shocks via stock markets also has a bearing on the design of monetary policy by policy makers (Berben and Jansen, 2005).

There is a vast literature on the study of stock market integration, but the majority of them falls short of addressing the globalization of stock markets per se by confining their analyses solely on panels of markets with similar characteristics. While some studies focus on markets in accordance with their maturity levels (for example, Berben and Jansen, 2005; De Jong and De Roon, 2005; Rua and Nunes, 2009; Umutlu et al., 2010), some others address integration on a regional basis (refer to Aggarwala and Kyaw, 2005; Apergis, et al. 2011; Click and Plummer, 2005; Hunter, 2006; Marashdeh and Shrestha, 2010; Moerman, 2008; Mylonidis and Kollias, 2010; Yu et al., 2010, for instance). An extensive coverage of these homogeneous market panels is found in Narayan et al. (2011). Although there are also works on investigating integration across these types of panels (for example, Caporale and Spagnolo, 2011; Mallik, 2006; Syllignakis and Kouretas, 2010; Yu and Hassan, 2008), to the best of our knowledge, only a few exceptions, including Bekaert et al. (2007, 2011) and Pukthuanthong and Roll (2009), are devoted to the study of market integration across the fuller board of global developed and emerging markets. With the onset of globalization, emerging markets have been actively engaging in liberalization activities and attracting considerable capital inflows due to high expected returns and opportunities for investment diversification (Arouri et al., 2010). This has, however, also contributed to a substantial increase in their financial vulnerability due to external shocks, as in the recent global financial crisis. Thus, empirical interest on global stock market integration has its practical grounding and financial significance, but has received limited attention on the contrary.

In this paper, we rethink stock market integration in the globalized context, and contribute to the meager literature on the issue by the systematic build-up of a unified conceptual framework for its analysis. The framework essentially comprises a working definition of market integration, an operational measure of it, and an appropriate methodology for its assessment. First and foremost, although there is no formal definition, it is commonly held that markets are integrated when the law of one price and the no arbitrage condition hold (Baele et al., 2004; Chen and Knez, 1995). Accordingly, assets with the same return and risk characteristics should be priced identically across markets. The relationship between asset characteristics and the pricing of an asset can be formulated in a standard stock valuation model.

Under the valuation model, our measure of market integration is based on the normalized valuations of stocks, including the earnings-price (EP), dividend-price (DP) and book-price (BP) ratios, along the lines of Bekaert et al. (2007). In so doing, we deviate from the common use of price and return measures in the literature, as in Pukthuanthong and Roll (2009), to test for market integration. Realized returns, according to Bekaert and Harvey (2000) and Fama and French (2002), are susceptible to high volatility and thus may bias the analytic results. By contrast, valuation ratios, which contain information on fundamentals such as expected return and growth opportunities of stocks, are less volatile and tend to give more precise estimates. Besides, the use of valuation ratios in analysis provides the convenience of comparison over time for the same stock and across stocks that may be denominated in different currencies (Bakshi and Chen, 2005; King and Segal, 2008).

It is not until recently that valuation ratios have gained favor as measures in studying stock market integration. EP is employed by Bekaert et al. (2007, 2011) and Eun and Lee (2010b), DP is used in De Jong and De Roon (2005), EP and DY are considered in Carrieri et al. (2004), whereas EP and BP are adopted by Land and Lang (2002) and King and Segal (2008). We take one step further and consider all three ratios in our analysis for at least three reasons. First, due to market-specific characteristics, one ratio may excel the other as the valuation apparatus. For example, while EP is important for valuation in the US market, book value appears to be a better measure for Japan (Bildersee et al., 1990). Second, empirical works suggest that a better indicator of fundamentals of stocks is a combination of these ratios. While Cheng and McNamara (2000) propose the combined EP-BP valuation method, Jiang and Lee (2007) develop the DP-BP model. Third, it is well-known that valuation ratios tend to differ across industrial sectors. The use of valuation ratios therefore facilitate our analysis of market integration at the industry level as to be discussed later on in this section. Under our valuation model with full market integration, fundamentals of stocks that are reflective in valuation ratios are driven by common global factors across markets. In other words, fully integrated markets are characterized by the same steady state balanced growth path of stock valuation in the long run. Thus, as markets become more integrated, valuation ratios across markets become more equalized, or converge to one another.

The above measurement approach for market integration suggests the convergence hypothesis that is commonly employed by macroeconomists to study cross-economy growth patterns as a suitable analytic methodology. As pointed out by Bruno et al. (2012), there is a lack of a theory of financial system convergence in the literature, so that existing empirical studies of Apergis, et al. (2011), Baele et al. (2004) and Narayan et al. (2011), which have employed different notions of the convergence methodology to study stock market integration, are susceptible to the risk of doing measurement without theory. The unified conceptual framework for stock market integration that we advance in this paper embeds globalized common factors across markets in a synthesis of the stock valuation model in finance and the convergence hypothesis in macroeconomics.

We shed light on global stock market integration at both the total market and the individual industrial sector levels. This is because integration (segmentation) at the total market level may come with different degrees of segmentation (integration) at the industry level, and knowledge of such is central for a comprehensive analysis of global market integration (Carrieri et al., 2004). However, market integration at the disaggregated level has largely been neglected in the literature, aside from the works of Bekaert et al. (2011), Berben and Janson (2005), Carrieri et al. (2004) and Rua and Nunes (2009), for instance. We therefore seek to provide empirical evidence not only on the extent of stock market integration in the ongoing globalization process, but also the extent to which aggregate market integration is driven by integration at the industry level.

The remainder of the paper is organized as follows. Section 2 constructs the stock valuation model, in three variants based on the ratios of EP, DP and BP, that lays the foundation for the investigation of global stock market integration. Section 3 establishes the technical link between stock valuation in market integration and the convergence hypothesis in growth empirics. Section 4 describes the large panel data set used in the empirical analysis, while

Section 5 details and discusses the empirical results. Section 6 summarizes and concludes.

2. Stock market integration

The definition of stock market integration employed in this paper is based on two well-established theorems, the law of one price and the absence of arbitrage (Rubinstein, 1976; Ross, 1978; Harrison and Kreps, 1979). The law of one price states that two assets with identical payoffs (in every state of nature) should not be priced differently. If the law fails to hold, then there arises profit opportunity from buying the cheaper asset and selling the more expensive one. In other words, a stochastic discount factor exists that prices all payoffs. But profit opportunity is still possible in the presence of zero or negatively priced assets which always yield nonnegative payoffs and positive payoffs with positive probability. Thus, the absence of arbitrage requires that the discount factor be strictly positive to rule out non-positive prices in practice. In the general international context, integrated stock markets should assign the same positive price to assets in different markets which yield the same payoffs by the law of one price and in the absence of arbitrage opportunities (Chen and Knez, 1995). Consequently, markets are integrated if there exists a strictly positive discount factor, which summarizes the pricing structure of a market, that is common across markets.

To formalize stock market integration in the above sense, consider a stock which belongs to a certain industry of market i. The stochastic discount factor, $\pi_{i,t+1}$, relates the stock's current price, $P_{i,t}$, to its price and dividend payoffs in the next period, $P_{i,t+1}$ and $DV_{i,t+1}$ respectively, as follows:

$$P_{i,t} = E_t\left[\pi_{i,t+1}(P_{i,t+1} + DV_{i,t+1})\right], \tag{1}$$

where E_t is the expectation given information at time t. Iterating this forward to infinity and assuming that the transversality condition, $E_t\left(\pi_{i,\tau}DV_{i,\tau}\right) \rightarrow 0$ as $\tau \rightarrow \infty$, holds, the current price of the stock equals the present value of all future dividends, that is:

$$P_{i,t} = E_t\left(\sum_{s=1}^{\infty} \pi_{i,t+s} DV_{i,t+s}\right). \tag{2}$$

Eq. (2) is the most fundamental stock valuation model, the dividend discount model, which gives the intrinsic value of the stock in level form. Allowing for time-varying log expected return and assuming continuous compounding, Eq. (2) becomes:

$$P_{i,t} = E_t\left[\sum_{s=1}^{\infty}\left(\prod_{k=0}^{s-1}\exp(-\rho_{i,t+k})\right) DV_{i,t+s}\right], \tag{3}$$

where $\rho_{i,t}$ is the expected return from time t to time $t+1$. This can be normalized by dividend to obtain the price-dividend ratio, popularized by Campbell and Shiller (1989):

$$PD_{i,t} = \frac{P_{i,t}}{DV_{i,t}} = E_t\left[\sum_{s=1}^{\infty}\exp\left(\sum_{k=0}^{s-1} -\rho_{i,t+k} + \triangle dv_{i,t+1+k}\right)\right], \tag{4}$$

where $dv_{i,t}$ denotes $\log(DV_{i,t})$. The price-dividend ratio evolves according to the state variables of expected return and dividend growth rate. Eq. (4) represents a measure of the normalized intrinsic value of the stock along the lines of Ang and Liu (1998), Lee et al. (1999) and Bakshi and Chen (2005).

Alternatively, Eq. (3) in level form of the intrinsic value can be normalized by earnings. For each time period, denote earnings by $EA_{i,t}$, the dividend payout ratio by $PO_{i,t}$ ($= DV_{i,t}/EA_{i,t}$), and their respective log forms by $ea_{i,t}$ and $po_{i,t}$. The following gives the widely used intrinsic valuation ratio, the price-earnings ratio, which depends on the expected return, payout ratio and earnings growth rate:

$$PE_{i,t} = \frac{P_{i,t}}{EA_{i,t}} = E_t\left[\sum_{s=1}^{\infty}\exp\left(\sum_{k=0}^{s-1} -\rho_{i,t+k} + \triangle po_{i,t+1+k} + \triangle ea_{i,t+1+k}\right) PO_{i,t}\right]. \tag{5}$$

Define the return on equity as $R_{i,t} = EA_{i,t}/BV_{i,t-1}$, where BV_t is the book value of the stock. The intrinsic value of the stock can be related to its book value by re-writing Eq. (4)

as:

$$PB_{i,t} = \frac{P_{i,t}}{BV_{i,t}} = E_t\left[\sum_{s=1}^{\infty} \exp\left(\sum_{k=0}^{s-1} -\rho_{i,t+k} + \triangle po_{i,t+1+k} + \triangle r_{i,t+1+k} + \triangle bv_{i,t+k} \right) \cdot PO_{i,t} R_{i,t} \frac{BV_{i,t-1}}{BV_{i,t}} \right], \quad (6)$$

with $r_{i,t}$ and $bv_{i,t}$ representing $\log(R_{i,t})$ and $\log(BV_{i,t})$ respectively. As thus, the price-book ratio is a function of the expected return, payout ratio, return on equity and the book value growth rate.

At the local market level, economic theory suggests that firms in the same industry should have similar valuation fundamentals. This is because they typically employ industry-specific production technology and operating policies and face similar market conditions, so that they are open to similar growth opportunities. Competition within the industry should eventually drive similar levels of risk and rates of return across firms. On the empirical front, Fabozzi and Francis (1979) find that different levels of risk associated with different investments can be attributed partly by the difference in levels of average risk of industries. Also, Nerlove (1968) shows that firms in the same industry typically experience similar industry-specific average rates of return.

In the international setting, globalization brings about increased cross-border economic and financial activities, advancement in information technology and dramatic evolutions of the financial markets as mentioned in Section 1. These have substantially reduced the significance of market-specific factors (Moerman, 2008). Stock market fundamentals across markets are increasingly driven by global macroeconomic and financial factors (Masih and Masih, 2002; Morana, 2008). The factor price equalization implication of classical trade theory (Samuelson, 1948) may also set in (Bekaert, 2011), with increased international trading activities and transfer of technologies across markets. The result is that international stock markets exhibit more systematic behavior in valuation over time (Eun and Lee, 2010b).

In fact, Bekaert et al. (2007) impose the simplifying assumption that all earnings are paid out as dividends, that is, $PO_{i,t} = 1$ and $PE_{i,t} = PD_{i,t}$, so that Eq. (5) collapses to Eq. (4). They maintain that earnings growths of an industry across integrated markets, $\triangle ea_{i,t} = \triangle dv_{i,t}$, are driven similarly by the stochastic worldwide growth opportunity factor pertaining to that industry, $GO_{w,t}$, which is the sole component of the earnings growth processes across markets that is persistent and priced (Rajan and Zingales, 1998; Fisman and Love, 2004). Furthermore, the expected return of each of the integrated markets in the same industry, $\rho_{i,t}$, depends only on the world expected return, $\rho_{w,t}$, and that these markets are exposed to common industry systematic risk. Assuming that each of $GO_{w,t}$ and $\rho_{w,t}$ follows an autoregressive process with normally distributed random shock, Bekaert et al. (2007) show that $PE_{i,t} = PD_{i,t}$ in Eq. (4) is derived as an infinite sum of exponentiated affine functions of the current realization of the world growth opportunity factor and world expected return:

$$PE_{i,t} = PD_{i,t} = \sum_{s=1}^{\infty} \exp\left(a_{i,s} + b_s\rho_{w,t} + c_s GO_{w,t}\right). \tag{7}$$

Linearizing Eq. (7) around the mean values of the growth opportunity factor and expected return results in:

$$pe_{i,t} = pd_{i,t} = \overline{a}_i + \overline{b}\rho_{w,t} + \overline{c}GO_{w,t}, \tag{8}$$

where $pe_{i,t}$ and $pd_{i,t}$ denote $\log(PE_{i,t})$ and $\log(PD_{i,t})$ respectively. Thus, full market integration implies that $PE_{i,t} = PD_{i,t}$ of the same industry across markets should be similar, albeit a time-invariant market-specific component. This is the steady state of stock valuation that is characterized by the state variables (stock fundamentals) of long-term growth rate and expected return (Lettau and Van Nieuwerburgh, 2007).

Relaxing the assumption of zero retention of earnings, the relationship between valuation and stock fundamentals can be deduced from the present value of growth opportunities (PVGO) concept (Bodie et al., 2011). Accordingly, the value of a stock can be thought of as the sum of the no-growth value of the firm and the present value of the firm's future investment opportunities, PVGO, made possible through earnings plowback. PVGO is positive and therefore value enhancing only when planned investments yield a return on equity greater than the expected rate of return, the discount rate. Thus, the valuation of a stock is closely tied to the payout ratio and return on equity in practice, which are not accounted for in the simplified model of Bekaert et al. (2007). Besides, it is also argued that it is price-book ratio, not price-earnings ratio, that is an appropriate indicator of earnings growth opportunities of a stock since the former reflects future profitability and is unaffected by current profitability (Penman, 1996). These considerations motivate our investigation of global stock market integration based on the trio of price-dividend, price-earnings and price-book ratios, which are popular valuation ratios for equity investment evaluation.

Our definition of stock market integration in the globalized context thus manifests in similar levels of stock valuation in accordance to Eqs. (4) to (6) across markets for the same industry. It can be noted that industrial sectors may not be integrated to the same degree, due to industry-specific characteristics. For instance, some industries, such as health care and utilities, may be highly regulated and nontradable in nature (Bekaert et al., 2007). Others, like the oil and gas sector, may be subject to the strong influence of local business cycle, or as in the case of the utilities sector, have limited presence of firms on foreign exchanges traditionally (Carrieri et al., 2004). For these industries, convergence of valuation ratios and therefore integration across markets are relatively more difficult to be realized than those industries that are less dependent on industry-specific factors. Market integration at the industry level for some dominating sectors or the majority of sectors then drives market integration at the aggregate level, as posited by Berben and Janson (2005), Carrieri et al. (2004) and Rua and Nunes (2009). Thus, as markets become more integrated, valuation ratios of stocks across markets, both at the total market and industry level, tend to converge to similar levels.

3. Convergence methodology

Since the existence of convergence of stock valuation ratios across markets is taken as supportive evidence for market integration, the convergence hypothesis established in economic growth empirics by macroeconomists is useful for the assessment of global stock market integration. Three notions of convergence, namely beta, log t and sigma, are particularly relevant to our present study.

The concept of beta convergence is a basic notion of convergence. Under the paradigm of the neoclassical growth theory (Solow, 1956), physical capital stock is subject to diminishing marginal returns. Accordingly, developing economies with lower levels of capital stock than developed economies commandeer higher rates of return on their physical capital, ceteris paribus. Capital is then expected to flow to the developing economies. Moreover, developing economies learn with the diffusion of knowledge and technology from the developed ones. Consequently, developing economies tend to grow faster than their developed counterparts initially, with catching up and thereby convergence in income level. The growth rates of developing economies then slow down, and the growth process eventually leads all economies to converge to a unique steady state balanced growth path characterized by the rate of growth of the technological progress in the long run (Islam, 1995). In the case of stock markets, the expected rates of return on investments tend to differ across markets, especially between developed and emerging markets. With the onset of the globalization process, the elimination of cross-border barriers to capital flows and the introduction of new financial products enable investment funds to be channeled internationally to places where the best risk-adjusted return can be reaped. At the same time, rapid transfer of technology, deregulation and harmonization of regulations and practices across markets reduce cross-market differences in risk-return characteristics and promote more similar growth opportunities across markets. Taken together, these forces drive stock valuation fundamentals across markets to become more equalized and tend to converge to the steady state of stock valuation under full market integration.

To test whether this type of convergence holds for a set of N markets indexed by i over a time period T indexed by t, a cross-sectional regression of valuation ratio average growth rate over this time period on the initial valuation ratio level can be employed (Barro and Salai-i-Martin, 1990, 1992):

$$\frac{1}{T-1}\left(y_{i,T}-y_{i,1}\right)=\alpha+\beta y_{i,1}+u_i,\ i=1,...,N, \tag{9}$$

where $y_{i,t}$ denotes the log of per share valuation ratio level of market i at time t, with u_i being the random error. The constant term α depends on the rate of growth of stock valuation fundamentals and the steady state valuation ratio level. A negative coefficient associated with the initial valuation level, β, is taken to indicate convergence in both valuation ratio level and growth rate, and hence known as beta convergence. The null hypothesis of $\beta = 0$ against the alternative of $\beta < 0$ is tested based on the t-statistic on the estimated slope coefficient. However, the beta convergence notion is an imperfect measure of level and growth convergence. Bernard and Durlauf (1996) posit that a negative β in the linear regression (9) is also consistent with multiple steady state models in which cross-market growth behavior is typically nonlinear. Furthermore, according to Phillips and Sul (2007a), this sort of regression falls short of accommodating the general case of heterogeneous technological progress across markets. A variant version of beta convergence that takes into account control factors (Barro and Salai-i-Martin, 1992; Mankiw et al., 1992) is of no avail, as it gives biased and inconsistent estimates in this general case (Phillips and Sul, 2007a, 2009).

Recently, Phillips and Sul (2007b, 2009) develop a nonlinear dynamic factor model for income under both time series and cross-sectional heterogeneity of technological progress, and examine convergence while also modeling the heterogeneous transitional dynamics of economic growth across economies. They assume that in a panel of economies, there exists in income per capita, $y_{i,t}$, a common trend component such as world technology, f_t . This time-varying common factor can be shared by individual economies to different extents in accordance with their individual characteristics, $b_{i,t}$, such that $y_{i,t} = b_{i,t} f_t$. The single common factor structure can be generalized in the stock valuation model where valuation ratio processes are driven by multiple common trend factors such as long-term growth and expected return under full market integration in that $y_{i,t} = \sum_{m=1}^{M} b_{m,i,t} f_{m,t} = \left(\sum_{m=1}^{M} b_{m,i,t} \frac{f_{m,t}}{f_{1,t}} \right) f_{1,t} = b_{i,t} f_t$. As such, $b_{i,t}$ measures the relative deviation of individual market from f_t, with f_t determining the common steady state growth path. The growth dynamics experience is heterogeneous among markets, and can be described by the relative transition parameter, $h_{i,t}$, constructed as:

$$h_{i,t} = \frac{y_{i,t}}{\frac{1}{N}\sum_{i=1}^{N} y_{i,t}} = \frac{b_{i,t}}{\frac{1}{N}\sum_{i=1}^{N} b_{i,t}}. \tag{10}$$

This measures the transition element $b_{i,t}$ for market i relative to the panel average at time t. The evolution of the relative transition parameter $h_{i,t}$ over time traces out the trajectory of each market relative to the average, which also measures the relative divergence of the market from the common steady state growth path. Despite possible transient diverging relative patterns, long run growth convergence among markets is possible if $\lim_{t\to\infty} \frac{y_{i,t}}{y_{j,t}} = 1$ for all $i \neq j$, or equivalently $\lim_{t\to\infty} b_{i,t} = b$ for all i. In other words, growth convergence occurs when $\lim_{t\to\infty} h_{i,t} = 1$ for all i. If $b_{i,t}$ converges faster than the divergence rate of f_t, level convergence is further implied.

To test for the null hypothesis of convergence for all i against the alternative of non-convergence for some i, the following time series regression is estimated:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log(\log t) = a + \gamma \log t + \epsilon_t,\ t = T_0, ..., T, \tag{11}$$

where $H_t = (1/N)\sum_{i=1}^{N} (h_{i,t} - 1)^2$ and $T_0 = [\kappa T]$ for some $\kappa > 0$, so that the first κ% of the time series data is discarded before carrying out regression. Under the null of growth convergence, $\gamma \geqslant 0$, whereas $\gamma < 0$ under the alternative. In the case of level convergence, the null and alternative hypotheses are changed to $\gamma \geqslant 2$ and $\gamma < 2$ respectively. The null hypothesis, whether growth or level convergence, is based on the t-statistic on the slope coefficient γ in Eq. (11). This is called the log t test due to the log t regressor, and we refer to this as the log t notion of convergence. Thus, growth convergence does not necessarily imply level convergence with the log t test. This corroborates the modeling under Eq. (8) that intrinsic valuation ratios across markets are driven by similar global factors but may still differ from one another by a time-invariant market-specific component.

Under the log t convergence framework, the transition and convergence experience can vary substantially from stock market to stock market. This is especially the case when many shocks, such as wars, major political and economic events and financial crises, affect markets differentially. These shocks tend to raise the cross-sectional variances of stock valuation ratios above their steady state levels. If the long run distributions of valuation ratios are unchanged, the rise in variances is temporary, and cross-sectional dispersions tend to fall gradually back to the steady state levels over time. This is what is termed the notion of sigma convergence (Baumol, 1986; Dowrick and Nguyen, 1989; Lichtenberg, 1994). To complement log t convergence, we are therefore also interested in the behavior of the distribution of valuation ratios across markets over time. This can be tested based on the likelihood ratio test of Carree and Klomp (1997), which is constructed according to:

$$\chi = (N - 2.5) \log \left[1 + \frac{1}{4} \frac{\left(\widehat{\sigma}_1^2 - \widehat{\sigma}_T^2\right)}{\widehat{\sigma}_1^2 \widehat{\sigma}_T^2 - \widehat{\sigma}_{1T}^2} \right], \tag{12}$$

where $\widehat{\sigma}_t^2 = (1/N) \sum_{i=1}^{N} \left(y_{i,t} - \overline{y}_t\right)^2$. $\widehat{\sigma}_t^2$ is the estimated cross-sectional variance, with $\overline{y}_t = (1/N) \sum_{i=1}^{N} y_{i,t}$ being the sample mean, and $\widehat{\sigma}_{1T}^2 = (1/N) \sum_{i=1}^{N} \left(y_{i,1} - \overline{y}_1\right) \left(y_{i,T} - \overline{y}_T\right)$ being the covariance of stock valuation between the first and last period. This test statistic has a chi-square distribution with 1 degree of freedom under the null hypothesis of no convergence.

4. Data description

To evaluate global stock market integration based on the stock valuation approach with the use of the convergence methodology, we collect EP, DP and BP ratios from DataStream's Global Equity Indices, which best serve our purpose in comparison with several other data sources. We consider EP, DP and BP in empirical study for the convenience that they are expressed in percentage terms. Since our analysis is based on their log transformation, results remain intact regardless of whether P is in the numerator or denominator of valuation ratios (Musumeci and Peterson, 2011).

The data base covers data for more than 50 markets. Data on certain markets are dropped in analysis for reasons of missing observations, short time span and/or non-positive values. Only time series with data available from 2000 or before are included in our data set as we are concerned with cross-market phenomena from a long-term perspective. In addition, time series with non-positive values are dropped, which follows from the notion of stock market integration that we define in Section 2. The resulting sample consists of 51 markets that spans the period January 1973 through July 2011. Monthly observations are being used which minimizes the influence of daily or weekly price fluctuations when compared with book values in terms of ratios. The monthly data are end-of-month figures.

For each market, DataStream covers a representative sample of stocks making up a minimum of 75 to 80% of total market capitalization. We refer to four leading market indices, namely Dow Jones Total Stock Market Index, FTSE Global Equity Index, MSCI and S&P Global Broad Market Index, to classify markets as either developed or emerging in our sample. Within each market, stocks are allocated to ten industrial sectors, which include basic materials, consumer goods, consumer services, financials, health care, industrials, oil and gas, technology, telecommunications and utilities, based on the Industry Classification Benchmark jointly created by Dow Jones and FTSE. This level of disaggregation shows the major differences among industries and avoids excessive details obscuring the overall picture of our analysis, especially when finer industrial breakdown reduces the number of stocks for many emerging markets substantially. Such broad industrial classification is also adopted in the literature to investigate the industry factor (Berben and Jansen, 2005; Moerman, 2008; Rua and Nunes, 2009).

With respect to EP and DP, data for the entire sample period are available for certain developed markets and the South African emerging market. As for the BP data, the earliest availability can be dated back to 1980 for similar markets. For all three ratios, it is not until the late 1980s that data for other developed markets and a few more emerging markets become available. Starting from the late 1990s, data began to appear for a large number of emerging markets. Subject to such data limitation, we consider three time periods with different starting dates but the same ending date of July 2011 in analysis. The first time period, named Period I, begins from January 1973 for EP and DP, and January 1980 for BP. The second and third time periods, named Periods II and III, commence from January 1990 and January 2000 respectively. As such, stock market integration can be studied among the same set of markets over time, instead of among a changing set of markets as data become available for them, which may bias the results. This is similar in essence to Pukthuanthong and Roll (2009), who categorize markets into cohorts according to the starting date of data availability. This time distinction is also consistent with the fact that the process of capital market liberalization can be traced back to the mid-1970s for the developed markets following the collapse of the Bretton Woods system (Eun and Lee 2010a), whereas the removal of capital controls for emerging markets mostly took place in the late 1980s and early 1990s (Bekaert and Harvey, 2000).

Abstracting from the voluminous description, we provide in Table 1 a snapshot of the data by presenting the averages of the means and standard deviations of the valuation ratios for the total market and the ten industrial sectors. Averages are calculated across the three market groups of all markets, and the subgroups of developed and emerging markets, over the three time periods under consideration. Notice that only groups with data available for at least three markets are included in testing for the different notions of convergence among stock markets. A listing of markets in our data set for EP, DP and BP can be found in Tables A.1, A.2 and A.3 respectively in the Appendix. The tables also include information on market classification and data availability in each time period.

Several patterns can be deduced from Table 1. First, the means of valuation ratios for certain industrial sectors are persistently higher than those of the total market for most or all market groups over time. These sectors include basic materials, consumer goods, and financials with respect to all three ratios, oil and gas regarding EP and DP, and utilities for DP and BP. Second, the sectoral volatilities of ratios measured in terms of standard deviation are often higher than the market volatility. Third, there is a tendency for the means and volatilities of valuation ratios to be higher for emerging markets than for developed markets. This trend is exhibited in both Periods II and III with regards to EP and DP, and Period III as regards BP. Fourth, for the all-market group with respect to EP and DP, the lowest means and volatilities generally appear in Period II, contributed by the low levels during 1990-2000. These observations provide support for our stock market integration investigation from the dimensions of total market, industrial sector, market group and time period.

5. Test results

In this section, we present and discuss the empirical results based on the three valuation ratios introduced in Section 2 to gauge the extent of global stock market integration through the use of the three notions of convergence discussed in Section 3.

5.1. Beta convergence

Fig. 1 provides scatter plots and fitted regression lines of the average growth rates and the log of the initial level of EP for different market groups in different time periods. Similarly, Figs. 2 and 3 are for DP and BP respectively. To conserve space, diagrams for different industrial sectors are not included here, but are available upon request. As shown in these figures, a clear negative relationship between the average growth rate of a ratio and its initial value is found. In other words, markets which start off to have high valuation ratios grow slower in their valuation ratios over time than markets with low initial valuation ratios. The estimated slope coefficients in Eq. (9) and their corresponding p-values of the t-statistics for testing the null of no beta convergence are displayed in Table 2. The t-statistics used in hypothesis testing are computed from heteroscedasticity-consistent standard errors. The test results provide overwhelming support for the notion of beta convergence with regards to the three valuation ratios for the total market across any market group over any time period.

Table 2 also contains the estimation and test results by industrial sector. Similar to the total market scenario, there is strong evidence in support of beta convergence for four industries, namely basic materials, consumer goods, financials and industrials. There are one or two instances of non-convergence for the industrial sectors of consumer services, technology, telecommunications and utilities. For consumer services and utilities, non-rejection of the no beta convergence occurs with respect to BP, in Period II among emerging markets for the former sector, and in Period I among developed markets for the latter. For technology, non-rejection occurs in Period I with developed markets based on EP. There is no evidence against the null of no beta convergence for telecommunications with regards to DP in Period I among developed markets, and in Period III among emerging markets. More non-rejections of the null are found for the health care and oil and gas sectors. For health care, there is evidence for divergence among emerging markets, using EP and DP in Period II, and EP in Period III. Turning to oil and gas, divergence is associated with BP among developed markets in Period I, and with both EP and DP across emerging markets in Period II.

In summary, according to the notion of beta convergence, stock market integration is found for the total market, which is largely driven by the industrial sectors of basic materials, consumer goods, financials and industrials. Health care and oil and gas are the least integrated industrial sectors, in Periods II and III for the former, and Periods I and II for the latter. In Periods II and III, the phenomenon of market segmentation, if any, occurs only among the emerging markets. Besides, conclusion for varying degrees of market segregation across industries is drawn from the use of different ratios, viz., all ratios for oil and gas, EP and DP for health care, EP for technology, DP for telecommunications, and BP for consumer services and utilities.

5.2. Log t convergence

Graphical illustrations of the relative transition paths of the total market with respect to EP, DP and BP are contained in Figs. 4, 5 and 6 respectively. Consider first Fig. 4 for EP. In Period I, the relative transition paths of some markets appear to diverge from the rest in the 1970s and the early 1980s, especially for Japan. Thereafter, a narrowing in the distances of the transition paths from one another is generally observed, especially towards the end of the period. Such patterns are observed regardless of the inclusion or exclusion of the South African emerging market. In Period II for the all-market group, the transition curves close in on each other over the entire period towards unity in general, except for Sri Lanka in 2000 and 2001, and Portugal towards the end of the period. Similar converging pattern can also be observed for the developed-market group. Emerging markets show more varied patterns over time. Their transition paths are seen to first converge until the mid-1990s, then diverge and eventually begin to converge again in the 2000s. In Period III, the transition parameters behave in a completely different manner. For all market groups, the curves first move towards unity in the first half of the period and then turn around to diverge from one another in the second half of the period.

We next turn to Fig. 5 for DP. In Period I, there is a clear tendency of divergence for the transition curves during the late 1980s and throughout the 1990s. The curves converge to more similar levels in the 2000s. For the all-market and developed-market groups in Period II, the transition curves remain persistently dispersed before 2000. A reduction in dispersion occurs thereafter, which is more evident for the latter market group with the removal of South Africa. As for the emerging-market group, there is a turnaround from the initial divergence of transition paths in around 1998. However, starting from the mid-2000s, the transition paths begin to move away from one another again. In Period III for all market groups, some large gaps exist among the transition paths in the early part of the period. These gaps appear to narrow down so that the transition parameters across markets come to more similar levels later on in the period.

From Fig. 6 for BP, it is observed that markets in Period I exhibit sharp divergence in values of the transition parameters in the early few years. The beginning of Period II for all market groups is also characterized by similar, though less pronounced, pattern. In addition, towards the end of the period, Ireland, which suffers from chronic financial and debt crisis, shows prominent divergence of its transition path from the rest. Considering the all-market group in Period III, large gaps exist among the transition curves both in the beginning and at the end of the period. The sizeable gaps can be attributed to those among the emerging markets in the beginning of the period, and those among the developed markets at the end of the period.

Overall, graphical observation suggests that for the total market in Period III, the transition parameters of markets are mostly dispersed in values away from unity towards the end of the period. This observation is consistent with the formal statistical test results for growth and level convergence shown in Table 3, which also displays the estimated coefficients for the log t variable in Eq. (11). Clearly, the null hypotheses of growth and level convergence are rejected at conventional significance levels based on EP for all market groups, and BP for the all-market and developed-market groups. In the rest of the scenarios for all periods, growth convergence is always supported, although level convergence is supported only for the all-market and developed-market groups in Period I using BP, and for the emerging-market group in Period II based on DP and BP.

Turning to the sectoral analysis, the industrial sector of consumer goods is the most supportive of the null of growth convergence, which is rejected only for the developed markets in Period I using BP. For the consumer services and technology industrial sectors, the growth convergence null is rejected only in Period III for all market groups, with EP and BP respectively. Regarding industrials, growth convergence is not supported only by BP in Periods I and III for the all-market and developed-market groups. With respect to the three industrial sectors of financials, oil and gas and telecommunications, null rejections are found in Periods II and III only. For financials, BP lends no support for growth convergence in both periods for the all-market and developed-market groups, while EP provides evidence against it for all market groups in Period III. As for oil and gas, growth convergence is rejected based on DP for all market groups in Period II. In Period III, both EP and BP give unfavorable evidence against the null for the all-market group, but mixed evidence for the other market groups. As regards telecommunications, rejections are found in Period II with BP only. In Period III, both EP and BP are against growth convergence for the all-market group, while mixed results are found for the other market groups based on all ratios. For the remaining sectors, there is evidence against growth convergence in all periods for different market groups based on different ratios.

Some interesting patterns derived from the sectoral test results for level convergence are as follows. This type of convergence is consistently supported by all ratios for the emerging-market group in Period II regarding the sectors of consumer goods and financials. In the same period, it is also supported for consumer services and industrials with the use of DP and BP. With respect to basic materials, BP is supportive of level convergence in all but one scenario in Periods II and III. As regards technology and telecommunications, non-rejection of the level convergence null is found using DP in Periods I and III in all scenarios considered, and for the developed-market group in all periods for the latter. Utilities, oil and gas and health care are the sectors that are least supportive of level convergence. The null of level convergence is not rejected only in one occasion for utilities, and two occasions for the other two sectors.

On the whole, based on the notion of log t convergence, stock market integration for the total market is largely supported for all market groups in Periods I and II. At the sectoral level, consumer goods is found to be the most integrated sector, especially beginning from the 1990s. The sectors of industrials, financials and technology are also highly integrated in the case of DP, where the growth convergence conclusion can be drawn for all market groups in all periods, and level convergence is further supported in some occasions. In contrast, market integration is mainly found for consumer services in Periods I and II, and for oil and gas in Period I only. The remaining sectors generally exhibit varying degrees of market integration in different time periods based on one or more valuation ratios. Overall, there is slightly more evidence for market segmentation in Period III than in the other periods. In this short Period III, developed markets are found to be slightly more segregated from one another than emerging markets. Besides, DP provides the most favorable evidence for market integration amongst all the ratios.

5.3. Sigma convergence

The cross-sectional standard deviations of the valuation ratios for the total market are plotted in Fig. 7. The test statistics and corresponding p-values for testing the null of no sigma convergence are presented in Table 4. Consider EP first. Fig. 7 shows marked sigma convergence in Period I, regardless of whether South Africa is included in analysis along with the developed markets. The standard deviations appear to decline in three steps, from the highest range in 1973-1989 to the middle range in 1990-2004, and eventually to the lowest range in 2005-2011. In Period II with the inclusion of more emerging markets, the standard deviations evolve in a similar fashion in that they decrease in two stages, from the higher level in 1990-2002 to the lower level from 2003 onwards. In Period III, however, a different picture appears. Both developed and emerging markets experience a sharp decrease in standard deviations before 2004. Thereafter, while standard deviations remain at low levels for developed markets, there is a big upswing for emerging markets until 2010, which completely nullifies the initial fall. The test results in Table 4 corroborate the graphical observations. The null of no sigma convergence is rejected in all scenarios except for emerging markets in Period III.

We next consider DP. In Period I, the standard deviations first increase and then decrease, with the final levels in 2011 still higher than the initial levels in 1973. In Period II, developed markets exhibit convergence until 2008 and slight divergence thereafter. As for emerging markets, the initial convergence is completely offset by the later divergence starting from 2004. There is a clear picture of a decrease in standard deviations for emerging markets in Period III, from the higher level in 2000-2003 to the lower level thereafter. However, developed markets first experience divergence, then convergence and divergence again, with the terminal standard deviations in 2011 not much lower than the starting values in 2000. The test results are also supportive of sigma convergence for developed markets in Period II, and emerging markets in Period III.

Turning to BP, after lingering at a high level for the first half of Period I, the standard deviations begin to decrease in the second half of the period. However, this decrease is not statistically significant enough to provide evidence for sigma convergence in this period. Throughout Period II, there is an evident downward trend for the standard deviations across emerging markets, but not across developed markets. Thus, the null of no sigma convergence is not rejected for the latter. In Period III, developed markets exhibit a U-turn in their standard deviations, which is consistent with the non-rejection conclusion from the test results.

From the test results for different industrial sectors, we find that the consumer goods sector is the most integrated, with the null of no sigma convergence not being rejected only for developed markets by BP in all periods, and in Period II with DP. Industrials and basic materials also exhibit relatively high degree of market integration in all periods for different market groups, especially with EP and DP for the former sector, and with EP for the latter. Health care is the most segregated industrial sector. Sigma convergence is supported only for emerging markets in Period III with BP. Results also indicate that the sectors of technology, oil and gas, telecommunications and utilities are rather segmented. Null rejections are found only in Periods II and III for these sectors. In the case of technology, rejection occurs only in two scenarios for the all-market group. Sigma convergence is more supported in Period III with DP and BP for all market groups with respect to utilities. Of the remaining two sectors, while there is evidence in support of sigma convergence in all periods regarding consumer services, evidence for sigma convergence is only found in Periods II and III concerning financials. Emerging markets are always found to be integrated using all ratios in Period III for the former, and in Periods II and III for the latter.

Overall, market segmentation prevails in all time periods to some degree. Whether developed or emerging markets are more segregated depends on the specific sector under investigation. Also, market segmentation is generally more supportive when using BP than with the other ratios.

6. Summary and conclusion

This paper rethinks stock market integration and adds to the meager literature by investigating the crucial issue of stock market integration across the board of global developed and emerging markets amidst the ongoing globalization process. We formulate a unified conceptual framework that embeds globalized common factors across markets by synthesizing the stock valuation model in finance and the convergence hypothesis in macroeconomics, and examine market integration that manifests in the convergence of the valuation ratios of different markets to a steady state balanced growth path in the long run. The spectrum of transition dynamics of markets towards integration is explored through examining the convergence processes of earnings-price, dividend-price and book-price ratios among markets in light of the notions of beta, log t and sigma convergence. We not only study integration at the total market level, but also attend to the often neglected industry integration by disaggregating the total market into the ten industrial sectors of basic materials, consumer goods, consumer services, financials, health care, industrials, oil and gas, technology, telecommunications and utilities. Our panel data spans the period January 1973 through July 2011. Market integration at both the aggregate and disaggregated levels for the global set of 51 developed and emerging markets is analyzed within the three overlapping time periods of Period I for 1973/1980-2011, Period II for 1990-2011, and Period III for 2000-2011, in accordance with the commencement date of data availability for different markets.

Our convergence test results from Tables 2, 3 and 4 are summarized in Table 5. As a whole, there is strong evidence for beta convergence, while results for log t convergence and sigma convergence are more mixed. Some interesting patterns can be deduced based on the several dimensions considered in our analysis. At the aggregate level, market integration for all markets is the least supported in Period III, which is reasonable given that this is the shortest time span with the largest market pool. In Periods II and III, emerging markets are slightly more integrated among themselves than are developed markets. The asymmetric extent of integration between the two groups of markets may be attributed to the recent financial and debt problems originating from developed markets.

At the industrial level for all markets, the extent of market integration also varies in different time periods. In Period I, the consumer services sector is the most integrated. In Period II, four industrial sectors, namely basic materials, consumer goods, consumer services and industrials, are found to be more integrated than the others. The consumer goods and industrials sectors remain relatively highly integrated in Period III. In contrast, the health care and utilities sectors are found to be the most segregated in Periods I and II. In Period III, the health care sector persists to be the most segmented, followed by the financials sector. It is interesting to find that in Period II for emerging markets, all notions of convergence suggest unanimously the very high degree of integration within the consumer goods and financials sectors irrespective of valuation ratio. However, results are less favorable for integration regarding the financials sector among developed markets. These observations may be explained by the various industry-specific factors at work. For instance, the financial sector may be distressed by local financial turmoil, whereas the oil and gas industry may be strongly influenced by local business cycle. The consumer goods sector is largely unregulated and tradable in nature relative to other sectors, which is not the case for the health care and utilities sectors. The utilities sector is further characterized by the limited presence of firms on foreign exchanges traditionally.

There are only a few occasions in which different valuation ratios give unanimous evidence for market integration regardless of the notion of convergence employed. Conclusion on integration with regards to the consumer goods sector is the most consistent across all valuation ratios regardless of market group, especially in Period III. Valuation ratios also give qualitatively similar integration inference in Period II at the total market level among all markets, for the technology sector among developed markets, and for the financials sector among emerging markets, as well as in Period III regarding the industrials sector among emerging markets. These observations may be due to the fact that different valuation ratios are reflective of similar but not exactly the same set of valuation fundamentals. With more intensified market integration, each of the valuation fundamentals across markets becomes increasingly driven by global common factors, and there is a tendency for the convergence of the same valuation fundamental across markets. However, the different fundamentals converge at varying speeds due to the heterogeneous transition dynamics of different markets, giving rise to conflicting evidence for market integration across the different valuation ratios.

In conclusion, the global stock market integration process is found to be time-varying in nature, as many emerging markets are still undergoing substantial development in their stock markets, and the transition paths of both developed and emerging markets towards ultimate convergence are constantly perturbed by shocks arising from major global political, economic and financial events. Besides, integration at the total market level comes with different degrees of integration at the industry level, due to the interplay of various industry-specific factors. On the whole, with the onset of the globalization process, we provide evidence that global stock markets are becoming more integrated under our unified valuation and convergence conceptual framework. However, markets are still far from ultimate full integration, as the global integration process is characterized by heterogeneous transition dynamics across markets and industries. Our results indicate that scrutinization of the determinants and the underlying mechanism for global stock market integration, especially at the industry level, would be useful for the design of appropriate international diversification strategies and coordinated inter-market monetary policies, which is left for future research.

References

Ang, A., Liu, J., 1998. A generalized earnings model of stock valuation. Research Paper No. 1491, Stanford University.

Apergis, N., Christou, C., Payne, J., 2011. Political and institutional factors in the convergence of international equity markets: Evidence from the club convergence and clustering procedure. Atlantic Economic Journal 39, 7-18.

Aggarwal, R., Kyaw, N.A., 2005. Equity market integration in the NAFTA region: evidence from unit root and cointegration tests. International Review of Financial Analysis 14, 393-406.

Arouri, M.E.H., Jawadi, F., Nguyen, D.K., 2010. The Dynamics of Emerging Stock Markets: Empirical Assessments and Implications. Physica-Verlag, Heidelberg.

Baele, L., Ferrando, A., Hordahl, P., Krylova, E., Monnet, C., 2004. Measuring financial integration in the Euro Area. Occasional Paper 14, European Central Bank.

Bakshi, G., Chen, Z., 2005. Stock valuation in dynamic economies. Journal of Financial Markets 8, 111-151.

Barro, R.J., Sala-i-Martin, X., 1990. Economic growth and convergence across the United States. NBER Working Paper No. 3419, National Bureau of Economic Research.

Barro, R.J., Sala-i-Martin, X., 1992. Convergence. Journal of Political Economy 100, 223-251.

Baumol, W., 1986. Productivity growth, convergence, and welfare: What the long-run data show. American Economic Review 76, 1072-1085.

Bekaert, G., Harvey, C.R., 2000. Foreign speculators and emerging equity markets. Journal of Finance 55, 565-613.

Bekaert, G., Harvey, C.R., Lundblad, C., 2005. Does financial liberalization spur growth? Journal of Financial Economics 77, 3-55.

Bekaert, G., Harvey, C.R., Lundblad, C., Siegel, S., 2007. Global growth opportunities and market integration. Journal of Finance 62, 1081-1137.

Bekaert, G., Harvey, C.R., Lundblad, C., Siegel, S., 2011. What segments equity markets. Netspar Discussion Paper 02/2011-031, Network for Studies on Pensions, Aging and Retirement.

Beine, M., Cosma, A.Vermeulen, R., 2010. The dark side of global integration: Increasing tail dependence. Journal of Banking and Finance 34, 184-192.

Berben, R.-P., Jansen, W.J., 2005. Comovement in international equity markets: A sectoral view. Journal of International Money and Finance, 24, 832-857.

Bernard, A.B., Durlauf, S.N., 1996. Interpreting tests of the convergence hypothesis. Journal of Econometrics 71, 161-173.

Bildersee, J.S., Cheh, J.J., Lee, C., 1990. The international price-earnings ratio phenomenon. Japan and the World Economy 2, 263-282.

Bodie, Z., Kane, A., Marcus, A.J., 2011. Investments, 9th ed. McGraw-Hill/Irwin: New York.

Bruno, G., Bonis, R., Silvestrini, A., 2012. Do financial systems converge? New evidence from financial assets in OECD countries. Journal of Comparative Economics 40, 141-155.

Campbell, J.Y., Shiller, R.J., 1989. The dividend-price ratio and expectations of future dividends and discount factors, Review of Financial Studies 1, 195-228.

Caporale, G.M., Spagnolo, N., 2011. Stock market integration between three CEECs, Russia, and the UK. Review of International Economics 19, 158-69.

Carree, M., Klomp, L., 1997. Testing the convergence hypothesis: A comment. Review of Economics and Statistics 79, 683-686.

Carrieri, F., Errunza, V., Sarkissian, S., 2004. Industry risk and market integration. Management Science 50, 207-221.

Chen, Z., Knez, P.J., 1995. Measurement of market integration and arbitrage. The Review of Financial Studies 8, 287-325.

Cheng, C.S.A., McNamara, R., 2000. The valuation accuracy of the price-earnings and price-book benchmark valuation methods. Review of Quantitative Finance and Accounting 15, 349-370.

Click, R.W., Plummer, M.G., 2005. Stock market integration in ASEAN after the Asian financial crisis. Journal of Asian Economics 16, 5-28.

Davis, G.F., Marquis, C., 2005. The globalization of stock markets and convergence in corporate governance. In: Nee, V., Swedberg, R. (Eds.), The Economic Sociology of Capitalism, Princeton University Press: Princeton and Oxford.

De Jong, F., De Roon, F. A., 2005. Time-varying market integration and expected returns in emerging markets. Journal of Financial Economics 78, 583-613.

Dowrick, S., Nguyen, D.-T., 1989. OECD comparative economic growth 1950-85: Catch-up and convergence. American Economic Review 79, 1010-1030.

Eun, C.S., Lee, J., 2010a. Mean-variance convergence around the world. Journal of Banking and Finance 34, 856-870.

Eun, C.S, Lee, J., 2010b. Evolution of earnings-to-price ratios: International evidence. Global Finance Journal 21, 125-137.

Fabozzi, F.J., Francis, J.C., 1979. Industry effects and the determinants of risk. Quarterly Review of Economics and Business 19, 61-74.

Fama, E.F., French, K.R., 1995. Size and book-to-market factors in earnings and returns. Journal of Finance 50, 131-155.

Fisman, R., Love, I., 2004. Financial development and intersector allocation: A new approach, Journal of Finance 59, 2785-2807.

Harrison, J.M., Kreps, D.M., 1979. Martingales and arbitrage in multiperiod securities markets. Journal of Economic Theory 20, 381-408.

Hunter, D.M., 2006. The evolution of stock market integration in the post-liberalization period - A look at Latin America. Journal of International Money and Finance 25, 795-826.

Islam, N., 1995. Growth empirics: A panel data approach. Quarterly Journal of Economics 110, 1127-1170.

Jiang, X., Lee, B.S., 2007. Stock returns, dividend yield, and book-to-market ratio. Journal of Banking and Finance 31, 455-475.

King, M.R., Segal, D., 2008. Market segmentation and equity valuation: Comparing Canada and the United States. Journal of International Financial Markets, Institutions and Money 18, 245-258.

Land, J., Lang, M.H., 2002. Empirical evidence on the evolution of international earnings. The Accounting Review 77, 115-133.

Lee, C.M.C., Myers, J., Swaminathan, B., 1999. What is the intrinsic value of the Dow? Journal of Finance 54, 1693-1741.

Lettau, M., Nieuwerburgh, S.V., 2007. Reconciling the return predictability evidence. Review of Financial Studies 21. 1607-1652.

Lichtenberg, F.R., 1994. Testing the convergence hypothesis. Review of Economics and Statistics 76, 576–579.

Mallik, G., 2006. Has the stock market integration between the Asian and OECD countries improved after the Asian crisis? Frontiers in Finance and Economics 3, 55-69.

Mankiw, N.G., Romer, D., Weil D.N., 1992. A contribution to the empirics of economic growth. The Quarterly Journal of Economics 107, 407-437.

Marashdeh, H.A., Shrestha, M.B., 2010. Stock market integration in the GCC countries. International Research Journal of Finance and Economics 37, 102-114.

Masih, A.M.M., Masih, R., 1999. Are Asian stock market fluctuations due mainly to intra-regional contagion effects? Evidence based on Asian emerging stock markets. Pacific-Basin Finance Journal 7, 251-282.

Masih, A.M.M., Masih, R., 2002. Propagative causal price transmission among international stock markets: evidence from the pre- and post globalization period. Global Finance Journal 13, 63-91.

Morana, C., Beltratti, A., 2008. Comovements in international stock markets. Journal of International Financial Markets, Institutions and Money 18, 31-45.

Morana, C., 2008. International stock markets comovements: the role of economic and financial integration. Empirical Economics 35, 333-359.

Moerman, G.A., 2008. Diversification in euro area stock markets: country versus industry. Journal of International Money and Finance 27, 1122-1134.

Musumeci, J., Peterson, M., 2011. BE/ME and E/P work better than ME/BE or P/E in regressions. Journal of Corporate Finance 17, 1272-1288.

Mylonidis, N., Kollias, C., 2010. Dynamic European stock market convergence: Evidence from rolling cointegration analysis in the first euro-decade. Journal of Banking and Finance 34, 2056-2064.

Narayan, P.K., Mishra, S., Narayan, S., 2011. Do market capitalization and stocks traded converge? New global evidence. Journal of Banking and Finance 35, 2771-2781.

Nerlove, M., 1968. Factors affecting differences among rates of return on investments in individual common stocks. Review of Economics and Statistics 50, 312-331.

Penman, S.H., 1996. The articulation of price-earnings ratios and market-to-book ratios and the evaluation of growth. Journal of Accounting Research 34, 235-259.

Phillips, P.C.B., Sul, D., 2007a. Some empirics on economic growth under heterogeneous technology. Journal of Macroeconomics 29, 455-469.

Phillips, P.C.B., Sul, D., 2007b. Transition modeling and econometric convergence tests. Econometrica 75, 1771-1855.

Phillips, P.C.B., Sul, D., 2009. Economic transition and growth. Journal of Applied Econometrics 24, 1153-1185.

Pukthuanthong, K., Roll, R., 2009. Global market integration: an alternative measure and its application. Journal of Financial Economics 94, 214-232.

Rajan, R., Zingales, L., 1998. Financial dependencies and growth. American Economic Review 88, 559-586.

Ross, S.A., 1978. A simple approach to the valuation of risky streams. Journal of Business 51, 453-475.

Rua, A., Nunes, L.C., 2009. International comovement of stock market returns: a wavelet analysis. Journal of Empirical Finance 16, 632-639.

Rubinstein, M., 1976. The valuation of uncertain income streams and the price of options. Bell Journal of Economics 7, 407-425.

Samuelson, P.A., 1948. International trade and the equalization of factor prices. Economic Journal 58, 163-184.

Solow, R.M., 1956. A contribution to the theory of economic growth. Quarterly Journal of Economics 70, 65-94.

Syllignakis, M.N., Kouretas, G.P., 2010. German, US and Central and Eastern European stock market integration. Open Economies Review 21, 607-628.

Umutlu, M., Akdeniz, L.,Altag-Salih, A., 2010. The degree of financial liberalization and aggregated stock-return volatility in emerging markets. Journal of Banking and Finance 34, 485-696.

Yu, I.W., Fung, K.P., Tam, C.S., 2010. Assessing financial market integration in Asia – Equity markets. Journal of Banking and Finance 34, 2874-2885.

Yu, J.-S., Hassan, M.K., 2008. Global and regional integration of the Middle East and North African (MENA) stock markets. The Quarterly Review of Economics and Finance 48, 482-504.

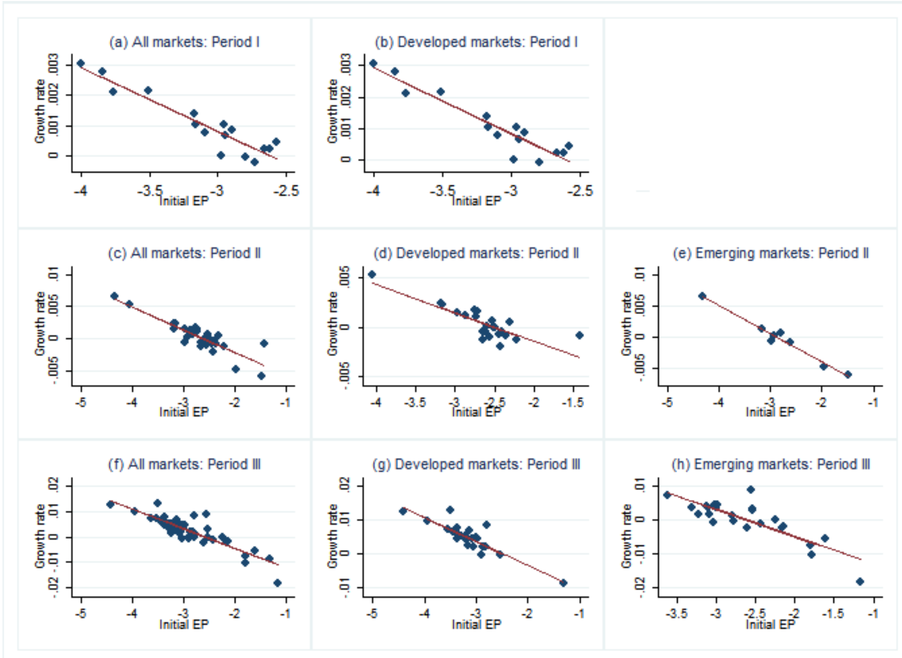

Figure 1. Average growth rate versus log initial level of EP

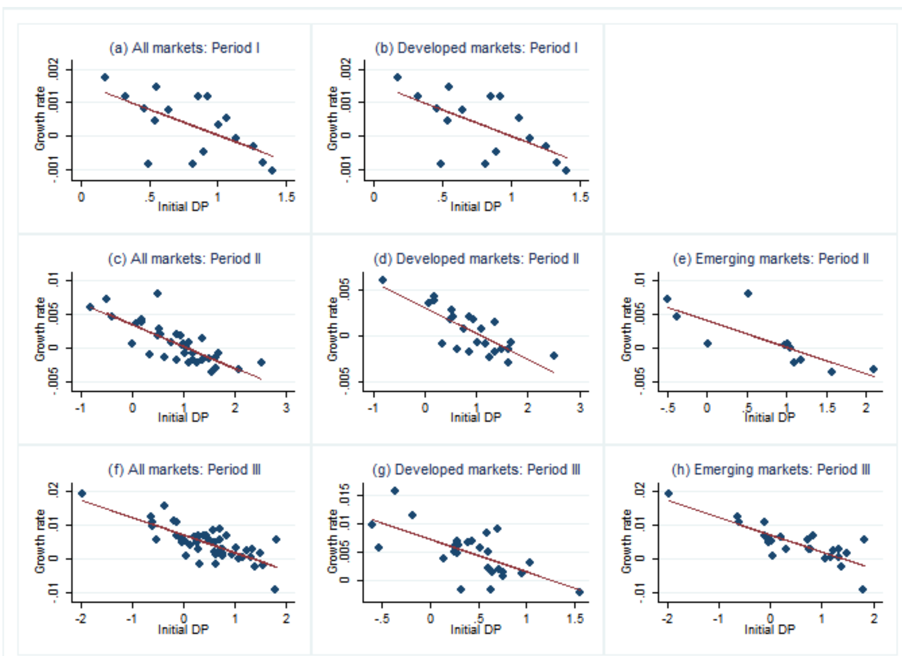

Figure 2. Average growth rate versus log initial level of DP

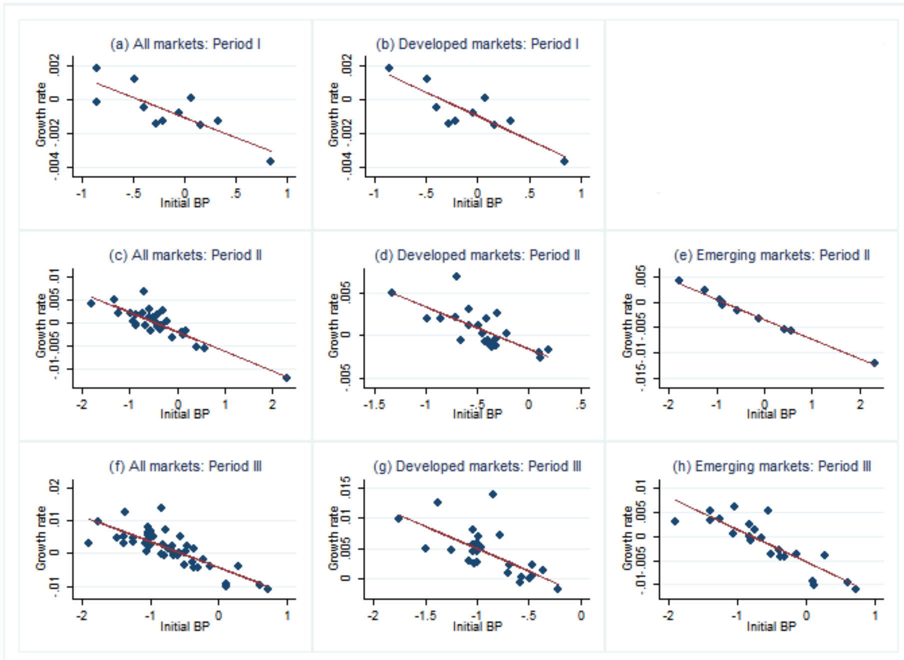

Figure 3. Average growth rate versus log initial level of BP

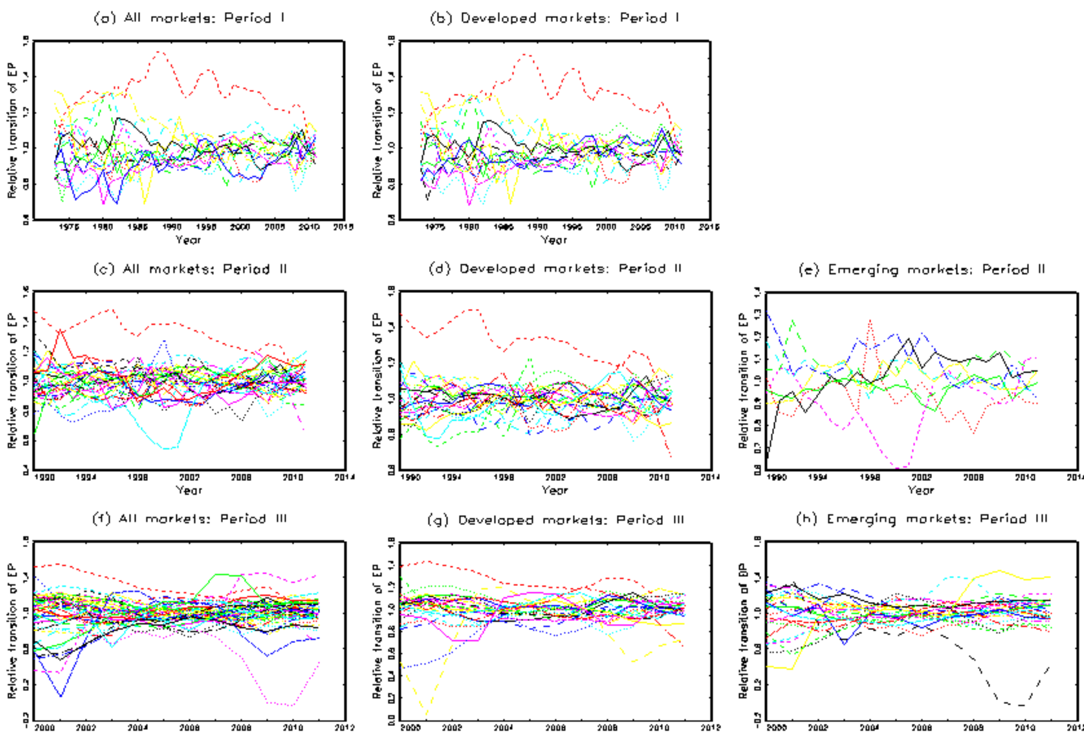

Figure 4. Relative transition paths of EP

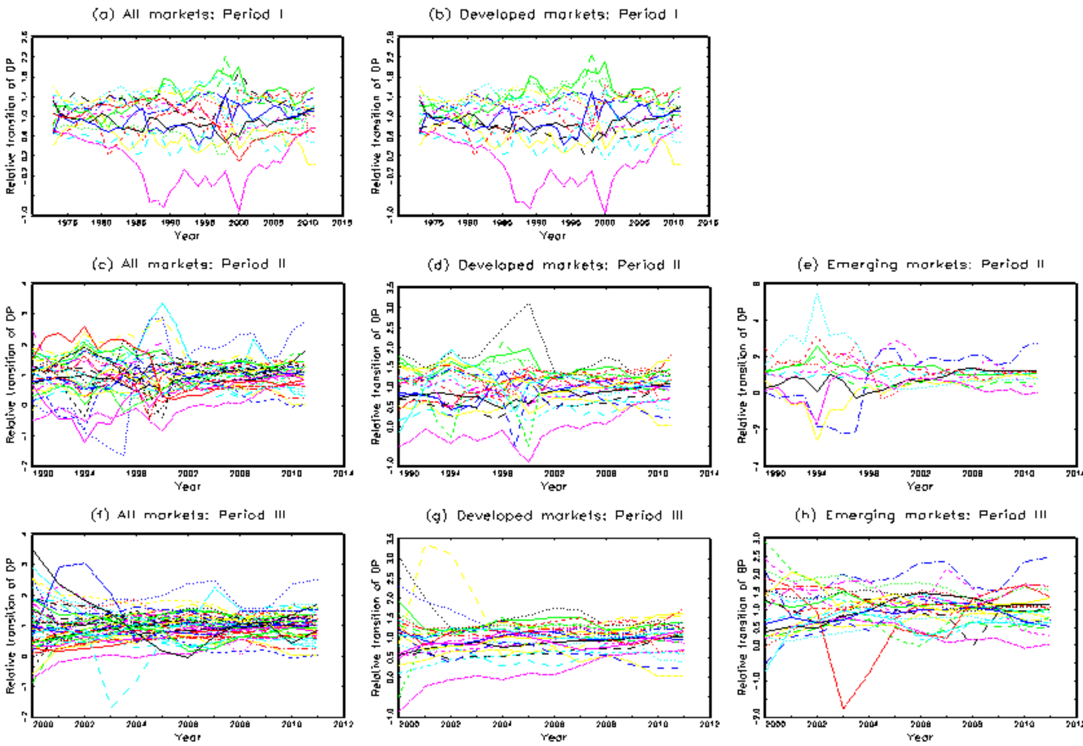

Figure 5. Relative transition paths of DP

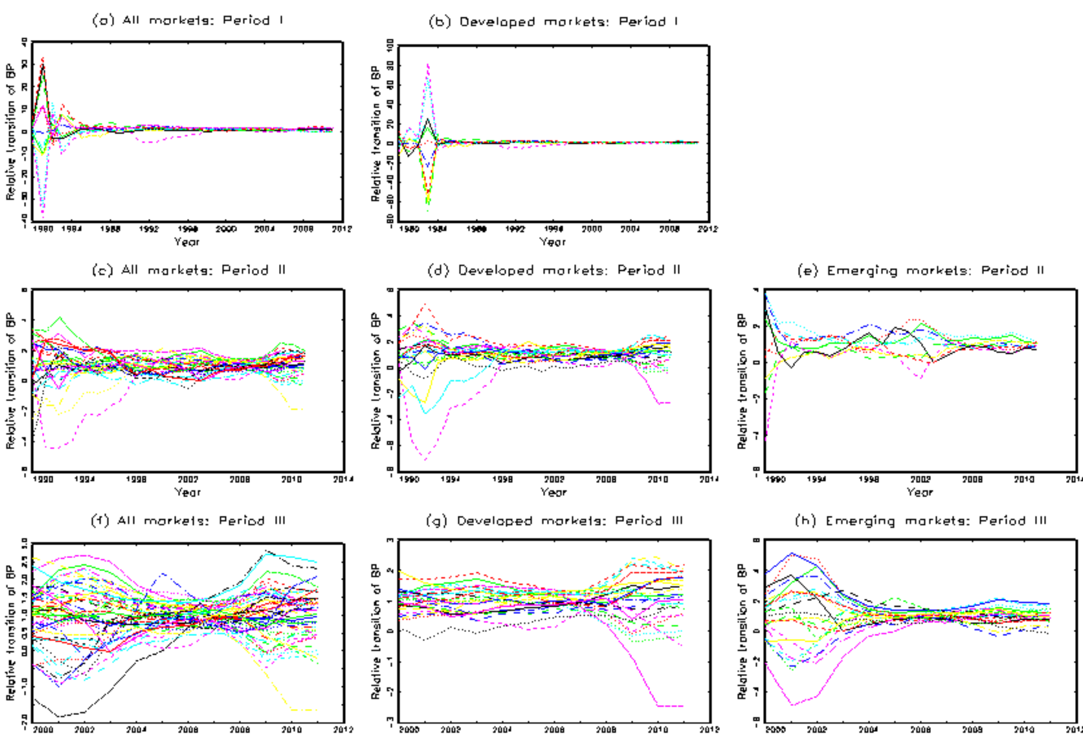

Figure 6. Relative transition paths of BP

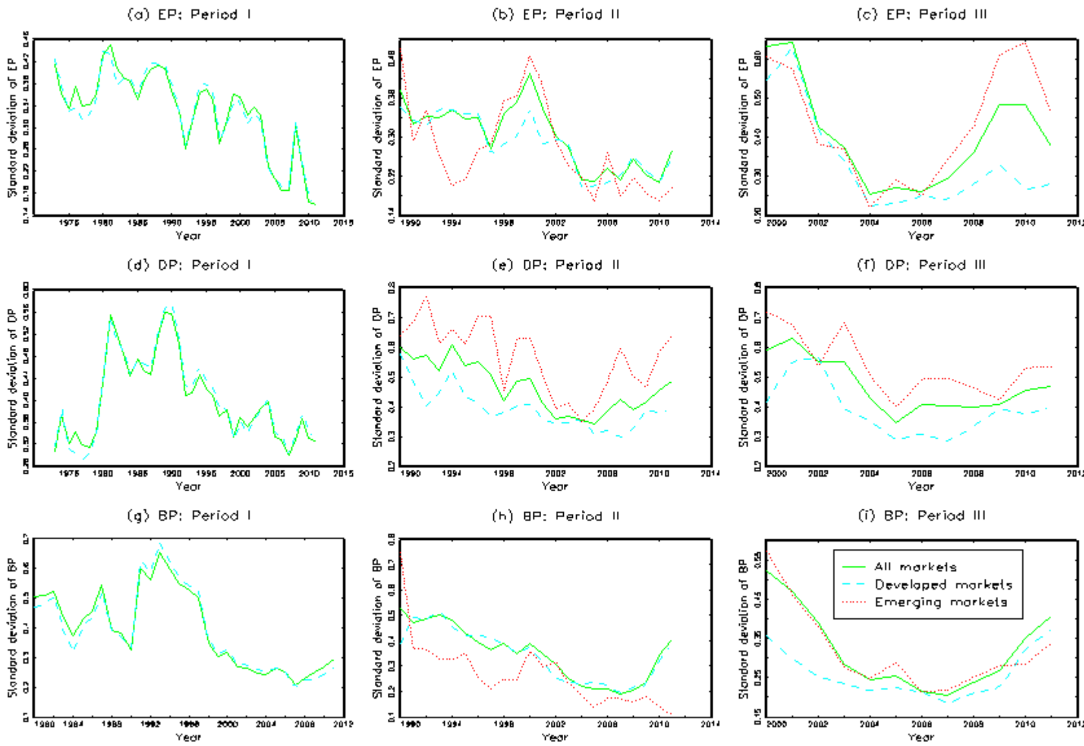

Figure 7. Cross-sectional standard deviations of EP, DP, and BP

Table 1

Descriptive statistics of EP, DP and BP.

	Period I			Period II			Period III		
	All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
EP (mean)									
Total	0.075	0.074	—	0.066	0.065	0.069	0.084	0.075	0.095
Basic materials	0.081		—	0.075	0.072	0.088	0.104	0.076	0.143
Consumer goods	0.088		—	0.076	0.073	0.080	0.083	0.083	0.082
Consumer services	0.066		—	0.057	0.057	0.056	0.064	0.064	0.065
Financials	0.083		—	0.079	0.081	0.075	0.100	0.096	0.105
Health care	0.068	0.065	—	0.055	0.053	0.063	0.061	0.051	0.081
Industrials	0.077	0.073	—	0.064	0.063	0.065	0.079	0.076	0.084
Oil and gas	0.084	0.082	—	0.068	0.065	0.075	0.095	0.078	0.113
Technology	0.052		—	0.052	0.052	—	0.050	0.046	0.057
Telecommunications	—		—	0.060	0.058	—	0.068	0.069	0.065
Utilities	0.073		—	0.069	0.067	—	0.078	0.066	0.094
EP (stardard deviation)									
Total	0.028	0.027	—	0.022	0.021	0.026	0.046	0.034	0.061
Basic materials	0.038		—	0.037	0.031	0.055	0.086	0.035	0.158
Consumer goods	0.049		—	0.045	0.041	0.052	0.048	0.050	0.045
Consumer services	0.028		—	0.023	0.022	0.029	0.034	0.032	0.039
Financials	0.051		—	0.041	0.043	0.033	0.075	0.065	0.086
Health care	0.029	0.028	—	0.021	0.019	0.028	0.028	0.020	0.043
Industrials	0.038	0.035	—	0.029	0.029	0.030	0.040	0.038	0.044
Oil and gas	0.046	0.046	—	0.028	0.026	0.033	0.047	0.031	0.064
Technology	0.026		—	0.037	0.037	—	0.028	0.028	0.029
Telecommunications	—		—	0.029	0.025	—	0.037	0.041	0.033
Utilities	0.030		—	0.027	0.024	—	0.038	0.025	0.054
DP (mean)									
Total	3.141	3.086	—	2.722	2.696	2.779	3.122	2.961	3.304
Basic materials	3.179		—	2.936	2.718	3.534	3.392	2.875	4.044
Consumer goods	3.844		—	2.739	2.610	2.954	3.165	3.106	3.255
Consumer services	2.925		—	2.436	2.460	2.362	3.016	3.508	1.944
Financials	3.420	3.404	—	3.229	3.377	2.744	3.544	3.581	3.500
Healthe care	2.899	2.779	—	2.318	2.317	2.325	3.074	2.194	5.213
Industrials	3.004	2.958	—	2.509	2.411	2.817	2.888	2.754	3.111
Oil and gas	3.894	3.838	—	3.181	3.267	2.923	3.959	3.408	4.680
Technology	2.286		—	1.562		—	1.409	1.201	2.174
Telecommunications	3.111		—	3.088	2.914	—	3.753	3.939	3.232
Utilities	4.471		—	3.449	3.427	—	3.840	3.546	4.281
DP (standard deviation)									
Total	1.201	1.161	—	1.090	0.886	1.535	1.309	1.210	1.421
Basic materials	1.346		—	1.704	1.230	3.008	1.837	1.265	2.560
Consumer goods	2.315		—	1.454	1.309	1.696	1.736	1.842	1.573
Consumer services	1.361		—	1.265	1.146	1.640	2.323	2.899	1.065
Financials	1.651	1.665	—	1.870	1.985	1.492	2.170	2.163	2.179
Healthcare	1.319	1.213	—	0.869	0.841	1.011	2.777	0.770	7.651
Industrials	1.376	1.345	—	1.309	1.036	2.166	1.589	1.161	2.301
Oil and gas	1.572	1.536	—	1.209	1.262	1.047	2.334	1.435	3.508
Technology	2.008		—	1.076		—	0.827	0.791	0.959
Telecommunications	1.664		—	2.075	1.614	—	1.974	1.762	2.568
Utilities	1.630		—	1.091	0.984	—	1.432	0.949	2.158

Table 1 *(continued)*

<table>
<tr><th></th><th colspan="3">Period I</th><th colspan="3">Period II</th><th colspan="3">Period III</th></tr>
<tr><th></th><th>All</th><th>Dev</th><th>Emg</th><th>All</th><th>Dev</th><th>Emg</th><th>All</th><th>Dev</th><th>Emg</th></tr>
<tr><td>BP (mean)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>0.733</td><td>0.759</td><td>—</td><td>0.635</td><td>0.654</td><td>0.591</td><td>0.614</td><td>0.583</td><td>0.651</td></tr>
<tr><td>Basic materials</td><td>0.638</td><td>0.670</td><td>—</td><td>1.235</td><td>1.364</td><td>0.819</td><td>1.152</td><td>0.961</td><td>1.434</td></tr>
<tr><td>Consumer goods</td><td colspan="2">0.581</td><td>—</td><td>0.823</td><td>0.895</td><td>0.607</td><td>0.634</td><td>0.616</td><td>0.655</td></tr>
<tr><td>Consumer services</td><td colspan="2">0.471</td><td>—</td><td>0.523</td><td>0.529</td><td>0.525</td><td>0.593</td><td>0.527</td><td>0.703</td></tr>
<tr><td>Financials</td><td colspan="2">0.998</td><td>—</td><td>0.829</td><td>0.872</td><td>0.639</td><td>0.775</td><td>0.811</td><td>0.731</td></tr>
<tr><td>Healthe care</td><td colspan="2">0.460</td><td>—</td><td colspan="2">0.441</td><td>—</td><td>0.562</td><td>0.587</td><td>0.513</td></tr>
<tr><td>Industrials</td><td>0.723</td><td>0.738</td><td>—</td><td>0.655</td><td>0.654</td><td>0.657</td><td>0.651</td><td>0.590</td><td>0.736</td></tr>
<tr><td>Oil and gas</td><td colspan="2">0.652</td><td>—</td><td>0.611</td><td>0.597</td><td>0.579</td><td>0.688</td><td>0.627</td><td>0.757</td></tr>
<tr><td>Technology</td><td colspan="2">—</td><td>—</td><td>0.499</td><td>0.506</td><td>—</td><td>0.469</td><td>0.402</td><td>0.611</td></tr>
<tr><td>Telecommunications</td><td colspan="2">—</td><td>—</td><td>0.573</td><td>0.566</td><td>—</td><td>0.491</td><td>0.466</td><td>0.524</td></tr>
<tr><td>Utilities</td><td colspan="2">0.616</td><td>—</td><td>0.712</td><td>0.716</td><td>—</td><td>0.886</td><td>0.842</td><td>0.950</td></tr>
<tr><td>BP (standard deviation)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>0.359</td><td>0.386</td><td>—</td><td>0.256</td><td>0.262</td><td>0.243</td><td>0.201</td><td>0.166</td><td>0.242</td></tr>
<tr><td>Basic materials</td><td>0.333</td><td>0.359</td><td>—</td><td>1.235</td><td>1.536</td><td>0.324</td><td>0.702</td><td>0.397</td><td>1.149</td></tr>
<tr><td>Consumer goods</td><td colspan="2">0.242</td><td>—</td><td>0.686</td><td>0.811</td><td>0.186</td><td>0.234</td><td>0.188</td><td>0.292</td></tr>
<tr><td>Consumer services</td><td colspan="2">0.237</td><td>—</td><td>0.302</td><td>0.327</td><td>0.141</td><td>0.305</td><td>0.314</td><td>0.289</td></tr>
<tr><td>Financials</td><td colspan="2">0.613</td><td>—</td><td>0.431</td><td>0.475</td><td>0.236</td><td>0.349</td><td>0.353</td><td>0.344</td></tr>
<tr><td>Healthe care</td><td colspan="2">0.255</td><td>—</td><td colspan="2">0.187</td><td>—</td><td>0.352</td><td>0.413</td><td>0.236</td></tr>
<tr><td>Industrials</td><td>0.444</td><td>0.472</td><td>—</td><td>0.292</td><td>0.312</td><td>0.218</td><td>0.213</td><td>0.170</td><td>0.274</td></tr>
<tr><td>Oil and gas</td><td colspan="2">0.292</td><td>—</td><td>0.241</td><td>0.207</td><td>0.197</td><td>0.253</td><td>0.217</td><td>0.294</td></tr>
<tr><td>Technology</td><td colspan="2">—</td><td>—</td><td>0.368</td><td>0.390</td><td>—</td><td>0.202</td><td>0.186</td><td>0.236</td></tr>
<tr><td>Telecommunications</td><td colspan="2">—</td><td>—</td><td>0.309</td><td>0.278</td><td>—</td><td>0.215</td><td>0.180</td><td>0.261</td></tr>
<tr><td>Utilities</td><td colspan="2">0.212</td><td>—</td><td>0.280</td><td>0.253</td><td>—</td><td>0.377</td><td>0.300</td><td>0.487</td></tr>
</table>

Note: One entry under columns "All" and "Dev" means markets are all developed.

Table 2

Beta convergence estimation and test results.

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Total										
EP	coef	-0.002^a	-0.002^a	—	-0.004^a	-0.003^a	-0.004^a	-0.008^a	-0.007^a	-0.008^a
	pv	0.000	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.002^a	-0.002^a	—	-0.003^a	-0.003^a	-0.004^a	-0.005^a	-0.006^a	-0.005^a
	pv	0.000	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
BP	coef	-0.002^a	-0.003^a	—	-0.004^a	-0.005^a	-0.004^a	-0.008^a	-0.007^a	-0.007^a
	pv	0.001	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
Basic materials										
EP	coef	-0.002^a		—	-0.004^a	-0.004^a	-0.005^a	-0.008^a	-0.007^a	-0.009^a
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.002^a		—	-0.003^a	-0.003^a	-0.003^b	-0.005^a	-0.005^c	-0.005^a
	pv	0.000		—	0.000	0.000	0.018	0.000	0.077	0.000
BP	coef	-0.002^a	-0.002^c	—	-0.004^a	-0.003^a	-0.011^a	-0.007^a	-0.006^a	-0.007^a
	pv	0.008	0.064	—	0.000	0.000	0.001	0.000	0.003	0.000
Consumer goods										
EP	coef	-0.002^a		—	-0.004^a	-0.003^a	-0.004^a	-0.007^a	-0.006^a	-0.006^a
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.001^a		—	-0.004^a	-0.003^a	-0.003^a	-0.006^a	-0.006^a	-0.006^a
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
BP	coef	-0.005^c		—	-0.004^a	-0.004^a	-0.008^a	-0.005^a	-0.004^a	-0.005^a
	pv	0.072		—	0.000	0.000	0.000	0.000	0.001	0.000
Consumer services										
EP	coef	-0.002^a		—	-0.004^a	-0.004^a	-0.007^c	-0.008^a	-0.008^a	-0.008^a
	pv	0.000		—	0.000	0.000	0.068	0.000	0.000	0.000
DP	coef	-0.002^a		—	-0.004^a	-0.004^a	-0.005^a	-0.006^a	-0.006^a	-0.006^a
	pv	0.004		—	0.000	0.000	0.000	0.000	0.000	0.007
BP	coef	-0.002^a		—	-0.004^a	-0.005^a	0.002	-0.006^a	-0.006^a	-0.006^a
	pv	0.002		—	0.000	0.001	0.629	0.000	0.000	0.000
Financials										
EP	coef	-0.003^a		—	-0.004^a	-0.004^a	-0.004^a	-0.007^a	-0.008^a	-0.007^a
	pv	0.000		—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.003^a	-0.003^a	—	-0.003^a	-0.003^a	-0.004^a	-0.007^a	-0.009^a	-0.006^a
	pv	0.001	0.001	—	0.000	0.000	0.000	0.000	0.000	0.000
BP	coef	-0.003^a		—	-0.004^a	-0.005^a	-0.004^a	-0.009^a	-0.013^a	-0.007^a
	pv	0.000		—	0.000	0.000	0.001	0.000	0.000	0.000
Health care										
EP	coef	-0.002^a	-0.002^a	—	-0.004^a	-0.004^a	-0.001	-0.004^c	-0.009^a	-0.002
	pv	0.000	0.000	—	0.000	0.000	0.269	0.076	0.000	0.169
DP	coef	-0.001^b	-0.001^b	—	-0.004^a	-0.004^a	0.004	-0.007^a	-0.006^a	-0.007^b
	pv	0.012	0.037	—	0.000	0.000	0.747	0.001	0.001	0.050
BP	coef	-0.003^c		—	-0.004^a		0.000^a	-0.006^a	-0.006^a	-0.006^a
	pv	0.088		—	0.006		0.000	0.000	0.008	0.003

Table 2 *(continued)*

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Industrials										
EP	coef	-0.003^a	-0.003^a	—	-0.005^a	-0.005^a	-0.005^a	-0.006^a	-0.005^a	-0.006^a
	pv	0.000	0.000	—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef	-0.002^a	-0.002^a	—	-0.003^a	-0.004^a	-0.002^b	-0.006^a	-0.005^a	-0.006^a
	pv	0.000	0.001	—	0.000	0.000	0.018	0.000	0.000	0.000
BP	coef	-0.003^a	-0.003^a	—	-0.004^a	-0.005^a	-0.003^a	-0.006^a	-0.007^a	-0.005^a
	pv	0.001	0.001	—	0.000	0.000	0.003	0.000	0.000	0.000
Oil and gas										
EP	coef	-0.002^b	-0.002^b	—	-0.004^a	-0.004^a	-0.005	-0.008^a	-0.008^a	-0.008^a
	pv	0.018	0.024	—	0.000	0.000	0.101	0.000	0.000	0.000
DP	coef	-0.001^b	-0.001^b	—	-0.003^a	-0.004^a	-0.002	-0.007^a	-0.010^a	-0.006^a
	pv	0.018	0.027	—	0.001	0.000	0.180	0.000	0.000	0.000
BP	coef	-0.004		—	-0.005^a	-0.005^a	-0.008^c	-0.006^a	-0.007^a	-0.005^b
	pv	0.240		—	0.000	0.001	0.075	0.000	0.000	0.016
Technology										
EP	coef	-0.001		—	-0.004^a	-0.005^a	—	-0.008^a	-0.007^a	-0.007^a
	pv	0.211		—	0.000	0.002	—	0.000	0.000	0.000
DP	coef	-0.002^b		—	-0.004^a		—	-0.007^a	-0.006^a	-0.007^c
	pv	0.014		—	0.001		—	0.000	0.009	0.057
BP	coef	—		—	-0.003^a	-0.003^a	—	-0.005^a	-0.006^a	-0.003^b
	pv	—		—	0.001	0.001	—	0.000	0.003	0.011
Telecommunications										
EP	coef	—	—	—	-0.004^a	-0.004^a	—	-0.007^a	-0.006^a	-0.008^a
	pv	—	—	—	0.000	0.000	—	0.000	0.000	0.000
DP	coef	-0.001		—	-0.003^a	-0.003^a	—	-0.007^a	-0.007^a	-0.003
	pv	0.206		—	0.000	0.001	—	0.000	0.000	0.395
BP	coef	—		—	-0.005^a	-0.005^a	—	-0.006^a	-0.006^a	-0.006^a
	pv	—		—	0.000	0.003	—	0.000	0.002	0.000
Utilities										
EP	coef	-0.004^b		—	-0.004^a	-0.005^a	—	-0.008^a	-0.009^a	-0.007^a
	pv	0.013		—	0.000	0.001	—	0.000	0.001	0.000
DP	coef	-0.002^a		—	-0.004^a	-0.003^a	—	-0.007^a	-0.006^a	-0.008^a
	pv	0.001		—	0.000	0.000	—	0.000	0.000	0.000
BP	coef	-0.003		—	-0.005^a	-0.005^a	—	-0.007^a	-0.008^a	-0.006^a
	pv	0.201		—	0.000	0.000	—	0.000	0.008	0.000

Notes: See note to Table 1.
"coef" is the estimated beta coefficient in Eq. (9) whereas "pv" is the p-value of the test statistic.
^{a}, ^{b} and ^{c} represent significance at the 1%, 5% and 10% levels respectively.

Table 3

Log t convergence estimation and test results.

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Total										
EP	coef	0.836_a	0.898_a	—	0.312_a	-0.167_a	1.205_b	-1.598^a_a	-1.169^a_a	-2.040^a_a
	pv1	1.000	1.000	—	0.799	0.323	0.998	0.000	0.000	0.000
	pv2	0.000	0.000	—	0.000	0.000	0.031	0.000	0.000	0.000
DP	coef	0.481_a	0.499_a	—	1.255_b	1.119_a	1.406	-0.009_a	-0.221_a	0.066_a
	pv1	0.878	0.891	—	0.999	1.000	0.992	0.478	0.177	0.633
	pv2	0.000	0.000	—	0.031	0.002	0.154	0.000	0.000	0.000
BP	coef	2.341	2.494	—	-0.358_a	-1.127_a	1.777	-1.846^a_a	-2.990^a_a	-0.366_a
	pv1	0.994	0.994	—	0.320	0.125	0.965	0.010	0.002	0.263
	pv2	0.642	0.692	—	0.001	0.001	0.410	0.000	0.000	0.000
Basic materials										
EP	coef	0.792_a		—	-0.300^c_a	-0.508^b_a	0.212_a	-0.676^a_a	-0.443^c_a	-1.007^b_a
	pv1	0.988		—	0.071	0.031	0.642	0.000	0.086	0.012
	pv2	0.000		—	0.000	0.000	0.001	0.000	0.000	0.000
DP	coef	-0.528^c_a		—	-0.279_a	-0.643_a	0.592_c	-1.126^a_a	-1.949^a_a	-0.499_a
	pv1	0.090		—	0.358	0.191	0.716	0.000	0.000	0.143
	pv2	0.000		—	0.001	0.000	0.087	0.000	0.000	0.000
BP	coef	-0.404_a	-0.546^c_a	—	1.925	1.720	2.486	1.414	0.539_c	4.096
	pv1	0.144	0.085	—	0.998	0.999	1.000	0.905	0.714	1.000
	pv2	0.000	0.000	—	0.456	0.303	0.768	0.294	0.062	0.957
Consumer goods										
EP	coef	1.257_c		—	0.556_a	0.083_a	1.597	0.485_a	0.672_a	0.379_a
	pv1	0.997		—	0.940	0.572	1.000	0.964	1.000	0.838
	pv2	0.053		—	0.000	0.000	0.126	0.000	0.000	0.000
DP	coef	0.275_b		—	1.349_c	1.335	1.595	-0.228_a	-0.411_a	0.110_a
	pv1	0.607		—	0.999	0.992	1.000	0.283	0.143	0.688
	pv2	0.044		—	0.071	0.115	0.176	0.000	0.000	0.000
BP	coef	-0.855^b_a		—	1.214_b	0.936_a	1.512	0.277_a	-0.007_a	0.860_a
	pv1	0.038		—	1.000	0.994	0.993	0.879	0.492	1.000
	pv2	0.000		—	0.014	0.002	0.213	0.000	0.000	0.000
Consumer services										
EP	coef	1.133_a		—	0.437_a	0.782_a	0.539_a	-0.684^a_a	-0.496^c_a	-0.563^c_a
	pv1	1.000		—	0.904	0.936	0.886	0.000	0.054	0.052
	pv2	0.000		—	0.000	0.009	0.001	0.000	0.000	0.000
DP	coef	-0.646_a		—	1.496	0.889_a	3.624	-0.546^b_a	0.055_a	-3.586^b_a
	pv1	0.170		—	0.997	0.993	0.989	0.040	0.601	0.033
	pv2	0.000		—	0.182	0.001	0.848	0.000	0.000	0.002
BP	coef	1.156		—	-0.545_a	-0.809_a	1.228	-0.484_a	-2.255^a_a	2.255
	pv1	0.954		—	0.188	0.137	0.921	0.230	0.003	1.000
	pv2	0.109		—	0.000	0.000	0.187	0.000	0.000	0.698
Financials										
EP	coef	0.603_a		—	0.073_a	-0.429_a	2.127	-0.991^b_a	-1.088^b_a	-0.845^b_a
	pv1	0.877		—	0.547	0.265	0.998	0.017	0.026	0.041
	pv2	0.004		—	0.001	0.000	0.570	0.000	0.000	0.000
DP	coef	0.413_a	0.369_a	—	0.702_b	0.238_a	2.671	-0.403_a	-0.938_a	0.225_a
	pv1	0.916	0.889	—	0.893	0.660	1.000	0.221	0.114	0.665
	pv2	0.000	0.000	—	0.011	0.001	0.801	0.000	0.000	0.000
BP	coef	5.533		—	-3.784^c_a	-2.554^c_a	2.166	-4.144^a_a	-7.560^a_a	-0.555_b
	pv1	0.990		—	0.051	0.072	0.946	0.001	0.000	0.334
	pv2	0.931		—	0.006	0.005	0.549	0.000	0.000	0.024
Health care										
EP	coef	-0.209_a	-0.001_a	—	-0.799^c_a	-1.625^a_a	2.514	-1.118^a_a	0.044_a	-2.719^a_a
	pv1	0.367	0.500	—	0.061	0.002	1.000	0.000	0.566	0.000
	pv2	0.000	0.009	—	0.000	0.000	0.767	0.000	0.000	0.000
DP	coef	-0.352_a	-0.293_a	—	0.307_a	0.362_a	0.446	-0.515_a	0.106_b	-2.151^a_a
	pv1	0.196	0.256	—	0.724	0.748	0.635	0.213	0.550	0.000
	pv2	0.000	0.000	—	0.001	0.001	0.115	0.000	0.012	0.000
BP	coef	-1.168^a_a		—	-0.595^c_a		—	-1.107^a_a	-1.564^a_a	0.105_a
	pv1	0.000		—	0.093		—	0.000	0.000	0.579
	pv2	0.000		—	0.000		—	0.000	0.000	0.000

Table 3 *(continued)*

			Period I			Period II			Period III		
			All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Industrials											
EP	coef		0.254_a	0.242_a	—	0.225_a	0.119_a	0.425_a	-0.451_a	-0.730_a	-0.186_b
	pv1		0.707	0.705	—	0.652	0.577	0.747	0.224	0.122	0.438
	pv2		0.000	0.000	—	0.001	0.001	0.007	0.000	0.000	0.033
DP	coef		-0.180_b	-0.169_b	—	1.781	2.027	1.746	0.505_a	1.216_b	-0.244_a
	pv1		0.429	0.435	—	1.000	1.000	0.990	0.959	0.999	0.121
	pv2		0.015	0.017	—	0.239	0.520	0.367	0.000	0.025	0.000
BP	coef		-1.003^b_a	-1.110^b_a	—	0.254_a	-0.057_a	1.936	-0.979^c_a	-1.908^b_a	-0.056_a
	pv1		0.049	0.040	—	0.634	0.470	0.940	0.059	0.012	0.470
	pv2		0.000	0.000	—	0.009	0.004	0.480	0.000	0.000	0.003
Oil and gas											
EP	coef		0.721_a	0.862_a	—	0.182_a	0.107_a	0.333_a	-0.817^a_a	-0.200_a	-1.013^a_a
	pv1		0.989	0.993	—	0.774	0.655	0.756	0.007	0.255	0.005
	pv2		0.000	0.001	—	0.000	0.000	0.000	0.000	0.000	0.000
DP	coef		0.527_a	0.562_a	—	-1.108^a_a	-0.529^c_a	-2.973^a_a	0.869_b	-0.150_a	1.112
	pv1		0.988	0.979	—	0.000	0.091	0.000	0.920	0.363	0.901
	pv2		0.000	0.000	—	0.000	0.000	0.000	0.034	0.000	0.152
BP	coef		-0.270_a		—	0.958	0.341_b	-0.635_a	-0.883^c_a	-1.221^b_a	-0.320_a
	pv1		0.378		—	0.848	0.641	0.231	0.089	0.041	0.324
	pv2		0.005		—	0.131	0.039	0.001	0.000	0.000	0.000
Technology											
EP	coef		1.337		—	0.131_a	0.249_a	—	-0.458_a	-0.906^b_a	-0.312_a
	pv1		0.992		—	0.597	0.663	—	0.136	0.012	0.298
	pv2		0.115		—	0.000	0.002	—	0.000	0.000	0.000
DP	coef		1.264		—	-1.570_b		—	4.701	2.927	2.800
	pv1		0.852		—	0.226		—	0.991	0.985	0.996
	pv2		0.271		—	0.044		—	0.914	0.754	0.779
BP	coef		—		—	0.208_a	-0.134_a	—	-1.810^a_a	-2.389^a_a	-1.484^a_a
	pv1		—		—	0.614	0.435	—	0.000	0.000	0.000
	pv2		—		—	0.006	0.005	—	0.000	0.000	0.000
Telecommunications											
EP	coef		—		—	1.008_b	0.906_b	—	-0.421^c_a	-0.141_a	-0.494^b_a
	pv1		—		—	0.982	0.969	—	0.094	0.375	0.044
	pv2		—		—	0.020	0.012	—	0.000	0.000	0.000
DP	coef		3.751		—	7.638	7.881	—	0.655_a	3.011	-2.267^b_a
	pv1		0.990		—	1.000	1.000	—	0.968	1.000	0.020
	pv2		0.860		—	1.000	1.000	—	0.000	0.971	0.000
BP	coef		—		—	-1.366^c_a	-3.344^a_a	—	-1.120^a_a	-1.595^a_a	-0.617_a
	pv1		—		—	0.051	0.000	—	0.000	0.000	0.132
	pv2		—		—	0.000	0.000	—	0.000	0.000	0.000
Utilities											
EP	coef		0.839_b		—	-1.034^c_a	-1.688^b_a	—	-1.988^a_a	-2.507^a_a	-1.656^a_a
	pv1		0.905		—	0.094	0.024	—	0.000	0.000	0.000
	pv2		0.035		—	0.000	0.000	—	0.000	0.000	0.000
DP	coef		0.437_a		—	-0.400_a	-0.166_a	—	-0.140_a	0.201_a	-0.399^c_a
	pv1		0.950		—	0.205	0.386	—	0.342	0.627	0.088
	pv2		0.000		—	0.000	0.000	—	0.000	0.002	0.000
BP	coef		-0.616^b_a		—	-1.170^b_a	-1.039^b_a	—	-0.700_a	-1.516^b_a	2.320
	pv1		0.031		—	0.023	0.040	—	0.234	0.026	0.948
	pv2		0.000		—	0.000	0.000	—	0.003	0.000	0.589

Notes: See note to Table 1.
"coef" is the estimated coefficient of the log t variable in Eq. (11).
"pv1" and "pv2" are the p-values for test statistics of growth and level convergence respectively.
^{a}, ^{b} and ^{c} represent significance at the 1%, 5% and 10% levels respectively for growth convergence.
$_a$, $_b$ and $_c$ represent significance at the 1%, 5% and 10% levels respectively for level convergence.

Table 4

Sigma convergence test results.

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Total										
EP	stat	12.515^a	12.281^a	—	12.549^a	7.702^a	10.831^a	11.521^a	7.567^a	1.756
	pv	0.000	0.000	—	0.000	0.006	0.001	0.001	0.006	0.185
DP	stat	0.028	0.029	—	4.827^b	5.565^b	0.525	9.189^a	0.241	8.452^a
	pv	0.866	0.864	—	0.028	0.018	0.469	0.002	0.623	0.004
BP	stat	1.665	1.648	—	5.516^b	0.821	24.722^a	1.690	0.361	6.530^b
	pv	0.197	0.199	—	0.019	0.365	0.000	0.194	0.548	0.011
Basic materials										
EP	stat	5.600^b		—	12.681^a	9.040^a	4.656^b	14.275^a	3.798^c	6.899^a
	pv	0.018		—	0.000	0.003	0.031	0.000	0.051	0.009
DP	stat	0.039		—	3.323^c	6.494^b	0.024	0.456	2.166	1.739
	pv	0.844		—	0.068	0.011	0.877	0.499	0.141	0.187
BP	stat	0.862	0.151	—	7.780^a	5.279^b	1.400	5.011^b	0.353	3.352^c
	pv	0.353	0.698	—	0.005	0.022	0.237	0.025	0.553	0.067
Consumer goods										
EP	stat	3.944^b		—	18.874^a	6.819^a	10.878^a	11.301^a	3.209^c	7.988^a
	pv	0.047		—	0.000	0.009	0.001	0.001	0.073	0.005
DP	stat	6.770^a		—	10.563^a	1.066	8.944^a	11.142^a	6.594^a	4.375^b
	pv	0.009		—	0.001	0.302	0.003	0.001	0.010	0.036
BP	stat	0.340		—	14.650^a	0.091	6.203^b	5.645^b	0.522	10.939^a
	pv	0.560		—	0.000	0.762	0.013	0.018	0.470	0.001
Consumer services										
EP	stat	11.392^a		—	8.870^a	19.581^a	0.237	9.789^a	6.869^a	4.590^b
	pv	0.001		—	0.003	0.000	0.627	0.002	0.009	0.032
DP	stat	0.022		—	1.154	0.298	4.908^b	2.258	1.701	3.536^c
	pv	0.881		—	0.283	0.585	0.027	0.133	0.192	0.060
BP	stat	3.708^c		—	4.951^b	7.621^a	0.237	3.975^b	0.074	10.227^a
	pv	0.054		—	0.026	0.006	0.627	0.046	0.786	0.001
Financials	stat									
EP	pv	1.577		—	8.623^a	4.592^b	10.052^a	8.746^a	1.271	7.782^a
	stat	0.209		—	0.003	0.032	0.002	0.003	0.260	0.005
DP	pv	2.087	1.814	—	2.551	0.173	4.568^b	1.123	3.490^c	5.305^b
	stat	0.149	0.178	—	0.110	0.677	0.033	0.289	0.062	0.021
BP	pv	1.550		—	5.581^b	4.510^b	4.777^b	1.582	8.769^a	12.335^a
		0.213		—	0.018	0.034	0.029	0.208	0.003	0.000
Health care										
EP	stat	2.191	1.527	—	1.745	1.248	0.274	0.083	0.003	0.092
	pv	0.139	0.217	—	0.186	0.264	0.600	0.774	0.957	0.762
DP	stat	0.083	0.006	—	0.116	0.061	0.701	0.292	0.092	0.078
	pv	0.774	0.938	—	0.733	0.804	0.403	0.589	0.762	0.781
BP	stat	0.047		—	0.012		—	0.399	2.591	3.517^c
	pv	0.828		—	0.912		—	0.528	0.107	0.061

Table 4 *(continued)*

		Period I			Period II			Period III		
		All	Dev	Emg	All	Dev	Emg	All	Dev	Emg
Industrials										
EP	stat	6.515^b	5.968^b	—	4.303^b	1.490	7.391^a	14.938^a	7.562^a	6.953^a
	pv	0.011	0.015	—	0.038	0.222	0.007	0.000	0.006	0.008
DP	stat	4.642^b	5.347^b	—	8.669^a	7.774^a	1.114	17.885^a	10.769^a	6.024^b
	pv	0.031	0.021	—	0.003	0.005	0.291	0.000	0.001	0.014
BP	stat	0.745	0.683	—	1.015	0.051	2.204	3.358^c	0.253	3.862^b
	pv	0.388	0.409	—	0.314	0.821	0.138	0.067	0.615	0.049
Oil and gas										
EP	stat	0.096	0.077	—	1.808	2.171	0.002	6.646^a	0.822	2.005
	pv	0.756	0.782	—	0.179	0.141	0.963	0.010	0.365	0.157
DP	stat	1.031	0.903	—	1.333	4.184^b	0.000	7.519^a	0.412	4.738^b
	pv	0.310	0.342	—	0.248	0.041	0.987	0.006	0.521	0.029
BP	stat	0.175		—	7.509^a	0.061	0.357	2.154	4.954^b	0.019
	pv	0.675		—	0.006	0.805	0.550	0.142	0.026	0.892
Technology										
EP	stat	0.135		—	3.120^c	0.587	—	1.983	1.351	0.367
	pv	0.713		—	0.077	0.444	—	0.159	0.245	0.545
DP	stat	1.825		—	0.792		—	4.283^b	0.070	0.744
	pv	0.177		—	0.373		—	0.038	0.791	0.388
BP	stat	—		—	1.959	2.140	—	0.597	0.385	0.110
	pv	—		—	0.162	0.143	—	0.440	0.535	0.740
Telecommunications										
EP	stat	—		—	3.785^c	1.943	—	2.994^c	0.725	4.286^b
	pv	—		—	0.052	0.163	—	0.084	0.395	0.038
DP	stat	0.059		—	8.552^a	6.210^b	—	2.782^c	14.803^a	1.429
	pv	0.809		—	0.003	0.013	—	0.095	0.000	0.232
BP	stat	—		—	0.028	0.130	—	1.273	0.063	1.508
	pv	—		—	0.867	0.719	—	0.259	0.802	0.220
Utilities										
EP	stat	0.699		—	0.117	2.081	—	0.009	8.426^a	2.081
	pv	0.403		—	0.733	0.149	—	0.923	0.004	0.149
DP	stat	2.023		—	5.064^b	6.359^b	—	15.879^a	4.802^b	8.130^a
	pv	0.155		—	0.024	0.012	—	0.000	0.028	0.004
BP	stat	0.360		—	1.867	0.450	—	5.734^b	9.184^a	4.392^b
	pv	0.548		—	0.172	0.502	—	0.017	0.002	0.036

Notes: See note to Table 1.
"stat" is the test statistic in Eq. (12) whereas "pv" is the corresponding p-value.
^{a}, ^{b} and ^{c} represent significance at the 1%, 5% and 10% levels respectively.

Table 5

Summary of beta, log t and sigma convergence test results.

	Beta convergence			Log t convergence						Sigma convergence		
				Growth			Level					
	EP	DP	BP	EP	DP	BP	EP	DP	BP	EP	DP	BP
Period I												
*All markets**	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N
Basic materials	Y	Y	Y	Y	N	Y	N	N	N	Y	N	N
Consumer goods	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N
Consumer services	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y
Financials	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	N
Health care	Y	Y	Y	Y	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N
Oil and gas	Y	Y	N	Y	Y	Y	N	N	N	N	N	N
Technology	N	Y	—	Y	Y	—	Y	Y	—	N	N	—
Telecommunications	—	N	—	—	Y	—	—	Y	—	—	N	—
Utilities	Y	Y	N	Y	Y	N	N	N	N	N	N	N
Period II†												
All markets	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Basic materials	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	Y
Financials	Y	Y	Y	Y	Y	N	N	N	N	Y	N	Y
Health care	Y	Y	Y	N	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	Y	N	Y	N	Y	Y	N
Oil and gas	Y	Y	Y	Y	N	Y	N	N	Y	N	N	Y
Technology	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	N
Telecommunications	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N
Utilities	Y	Y	Y	N	Y	N	N	N	N	N	Y	N
Developed markets	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	N
Basic materials	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	Y	N	Y	N	N
Consumer services	Y	Y	Y	Y	Y	Y	N	N	N	Y	N	Y
Financials	Y	Y	Y	Y	Y	N	N	N	N	Y	N	Y
Health care	Y	Y	Y	N	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	Y	N	Y	N	N	Y	N
Oil and gas	Y	Y	Y	Y	N	Y	N	N	N	N	Y	N
Technology	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N
Telecommunications	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N
Utilities	Y	Y	Y	N	Y	N	N	N	N	N	Y	N
Emerging markets	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y
Basic materials	Y	Y	Y	Y	Y	Y	N	N	Y	Y	N	N
Consumer goods	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Consumer services	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	N
Financials	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Health care	N	N	Y	Y	Y	—	Y	Y	—	N	N	—
Industrials	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	N
Oil and gas	N	N	Y	Y	N	Y	N	N	N	N	N	N
Technology	—	—	—	—	—	—	—	—	—	—	—	—
Telecommunications	—	—	—	—	—	—	—	—	—	—	—	—
Utilities	—	—	—	—	—	—	—	—	—	—	—	—

Table 5 *(continued)*

	Beta convergence			Log t convergence						Sigma convergence		
				Growth			Level					
	EP	DP	BP	EP	DP	BP	EP	DP	BP	EP	DP	BP
Period III												
All markets	Y	Y	Y	N	Y	N	N	N	N	Y	Y	N
Basic materials	Y	Y	Y	N	N	Y	N	N	Y	Y	N	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	N	N	Y	N	N	N	Y	N	Y
Financials	Y	Y	Y	N	Y	N	N	N	N	Y	N	N
Health care	Y	Y	Y	N	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	Y
Oil and gas	Y	Y	Y	N	Y	N	N	N	N	Y	Y	N
Technology	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N
Telecommunications	Y	Y	Y	N	Y	N	N	N	N	Y	Y	N
Utilities	Y	Y	Y	N	Y	Y	N	N	N	N	Y	Y
Developed markets	Y	Y	Y	N	Y	N	N	N	N	Y	N	N
Basic materials	Y	Y	Y	N	N	Y	N	N	N	Y	N	N
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	N	Y	N	N	N	N	Y	N	N
Financials	Y	Y	Y	N	Y	N	N	N	N	N	Y	Y
Health care	Y	Y	Y	Y	Y	N	N	N	N	N	N	N
Industrials	Y	Y	Y	Y	Y	N	N	N	N	Y	Y	N
Oil and gas	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y
Technology	Y	Y	Y	N	Y	N	N	Y	N	N	N	N
Telecommunications	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N
Utilities	Y	Y	Y	N	Y	N	N	N	N	Y	Y	Y
Emerging markets	Y	Y	Y	N	Y	Y	N	N	N	N	Y	Y
Basic materials	Y	Y	Y	N	Y	Y	N	N	Y	Y	N	Y
Consumer goods	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Consumer services	Y	Y	Y	N	N	Y	N	N	Y	Y	Y	Y
Financials	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y
Health care	N	Y	Y	N	N	Y	N	N	N	N	N	Y
Industrials	Y	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y
Oil and gas	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N
Technology	Y	Y	Y	Y	Y	N	N	Y	N	N	N	N
Telecommunications	Y	N	Y	N	N	Y	N	N	N	Y	N	N
Utilities	Y	Y	Y	N	N	Y	N	N	Y	N	Y	Y

Notes: "Y" indicates evidence for convergence whereas "N" signifies evidence against convergence.
* Results for all markets are qualitatively applicable to developed markets except with BP for basic materials.
† In Period II, markets are all developed with BP in the health care sector, and with DP in the technology sector.

Appendix

The sample contains 51 markets, of which 27 are developed and 24 are emerging, with the latter marked with ^{e}. Each market total is disaggregated into ten industrial sectors, namely (1) Basic Materials, (2) Consumer Goods, (3) Consumer Services, (4) Financials, (5) Health Care, (6) Industrials, (7) Oil and Gas, (8) Technology, (9) Telecommunications and (10) Utilities. For each market and industrial sector, the span of data used, subject to data availability, can be distinguished into the three time periods of (A) Period I: 1973/1980-2011, (B) Period II: 1990-2011 and (C) Period III: 2000-2011.

Table A.1

Data of EP by market, industrial sector and time period.

Markets	Total	1	2	3	4	5	6	7	8	9	10
ARGENTINA^e	C				C						C
AUSTRALIA	A	A		A	A	A	A	A		C	A
AUSTRIA	A	A			A		C	C			B
BELGIUM	A	A	C	B	A	B	B		B		A
BRAZIL^e	C	C	C		C		C	C		C	C
CANADA	A	A	B	B	B		A	A	A	B	A
CHILE^e	B	B	B	B	B		B	B		B	B
CHINA^e	C	C	C		C		C	C	C		C
COLOMBIA^e	C	C	C	C	C				C		C
CYPRUS	C	C	C	C	C		C				
CZECH REP^e	C				C	C	C	C			C
DENMARK	A		B	C	A	A	A			C	
EGYPT^e	C		C		C		C				
FINLAND	B	C		B	B		B		B		C
FRANCE	A	A	A	A	A	A	A	A	A	C	
GERMANY	A	A	A	A	B	A	A		C		A
GREECE	B	B		C	B		B	C			
HUNGARY^e	C		C	C	C	C	C		C	C	C
HONG KONG	A	B	C	A	A		A	C	B	B	A
INDIA^e	B	B	B	C	C	B	B	B	C	C	B
INDONESIA^e	C	C			C	C		C		C	
IRELAND	A		C	A	A	B					
ISRAEL	C	C	C	C	C	C	C	C			
ITALY	B	B	B	B	B	B	B	B		B	B
JAPAN	A	A	A	A	A	A	A	A	A	A	A
KOREA	B	B	B	B	B	B	B	B	C	B	B
LUXEMBURG	C	C	C	C	C		C				
MALAYSIA^e	B	B	B	B	B		B	B		C	C
MEXICO^e	C	C		C	C		C			C	
NETHERLANDS	A	A	A	A	A	A	A	A	B		
NEW ZEALAND	B		B	B	B	B	C				C
NORWAY	B	B	C		B		B	B	C		
PAKISTAN^e	C	C	C		C	C	C	C			C
PHILIPPINES^e	B		B	C	B	B	C			B	C
PERU^e	C	C			C						
POLAND^e	C	C	C	C	C				C	C	
PORTUGAL	B	B	B	C	B		B			C	C
ROMANIA^e	C	C	C	C	C	C	C	C			
RUSSIA^e	C				C			C			
SINGAPORE	A	A	B	A	A	A	A			C	
SOUTH AFRICA^e	A	C	C	C	B	A	A	A	C	C	
SPAIN	B	B	C	B	B	B	B	B		B	B
SRI LANKA^e	B	B	B	C	B		B	C			
SWEDEN	B	B	B	B	B	C	B			C	C
SWITZERLAND	A	A	B	A	A	A	A		B	C	A
TAIWAN^e	B	B	B	B	B		B		B		
THAILAND^e	B	B	B	B	B	B		C	C	C	C
TURKEY^e	C		C	C	C		C	C			C
UK	A	A	A	A	A	A	A	A	B	B	B
US	A	A	A	A	A	A	A	A	A	A	A
VENEZUELA^e	C	C			C						

Table A.2

Data of DP by market, industrial sector and time period.

Markets	Total	1	2	3	4	5	6	7	8	9	10
ARGENTINA^e	C	C			C						
AUSTRALIA	A	A	A	A	A	A	A	A		C	A
AUSTRIA	A	A			A		B	C			B
BELGIUM	A	A	C	A	A	B	B	C	B		A
BRAZIL^e	C	C	C		C		C	C		C	C
CANADA	A	A	B	A	A		A	A		B	A
CHILE^e	B	B	B	B	B		B	B		B	B
CHINA^e	C	C	C				C	C			C
COLOMBIA^e	C	C	C		C						C
CYPRUS	C	C	C	C	C						
CZECH REP^e	C				C	C					C
DENMARK	A	B	C		A	A	A				
EGYPT^e	C	C	C		C	C	C				
FINLAND	B	B		B	B	B	B		B		C
FRANCE	A	A	A	A	A	A	A	A	A	C	
GERMANY	A	A	A	A	A	A	A		B	A	A
GREECE	B	B		C	B		B	C		C	
HUNGARY^e	C					C					C
HONG KONG	A	B	C	A	A		A		B		A
INDIA^e	B	B	B	C	C	B	B	B	C	C	B
INDONESIA^e	C	C								C	
IRELAND	A		C	A	A						
ISRAEL	C	C	C	C	C	C	C	C			
ITALY	A	A	A	B	A	B	A	B		B	B
JAPAN	A	A	A	A	A	A	A	A	A	A	A
KOREA	B	B	B	B	B		B	B	C	B	
LUXEMBURG	C		C	C	C		C				C
MALAYSIA^e	B	B	B	B	B		B	B			C
MEXICO^e	B	B		B	C		C			C	
NETHERLANDS	A	A	A	A	A	A	A	A	B		
NEW ZEALAND	B	B	B	B	B	B	C	B		C	C
NORWAY	B	B	C				B	B	C		B
PAKISTAN^e	C	C	C		C	C	C	C			C
PHILIPPINES^e	B		B	C	B		C				
PERU^e	C	C			C						C
POLAND^e	C	C	C		C			C			
PORTUGAL	B	B	B	C	B		B				C
ROMANIA^e	C	C			C		C	C			
RUSSIA^e	C			C	C			C			
SINGAPORE	A		B	A	A	A	A	C		C	
SOUTH AFRICA^e	A	C	B	B	A	A	A	A	C		
SPAIN	B	B		B	B	B	B	B			B
SRI LANKA^e	B	B	B	C	B		B	C			
SWEDEN	B	B	B	B	B	C	B			C	B
SWITZERLAND	A	A	B	A	A	A	A			C	A
TAIWAN^e	B	B	B	B	B		B		C		
THAILAND^e	B	B	B	B	B	B		C			C
TURKEY^e	B		B	C	C		C	C			C
UK	A	A	A	A	A	A	A	A	A	B	B
US	A	A	A	A	A	A	A	A	A	A	A
VENEZUELA^e	B	B			C		B				

Table A.3

Data of BP by market, industrial sector and time period.

Markets	**Total**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
ARGENTINA[e]	B	C	B	C	C		C	B		C	C
AUSTRALIA	A	A	C	B	A	C	B	B		C	
AUSTRIA	A	B			B		A	B			B
BELGIUM	A	A	C	C	A	A	A	C	C		
CANADA	B	B	B	B	B	C	B	B	C	B	B
CHILE[e]	B	B	B	C	C		B	B		B	B
CHINA[e]	C	C	C		C		C				C
COLOMBIA[e]	C	C	C	C	C		C	C			C
CZECH REP[e]	C	C	C		C			C	C	C	C
DENMARK	A		B		A	A	A	C		C	C
EGYPT[e]	C	C	C		C	C	C			C	
FINLAND	B	B	B	B	B		B		B	C	C
FRANCE	B	B	B	B	B	B	B	B	B		B
GERMANY	A	A	A	A	A	A	A		B	C	A
GREECE	B	C	B	B	B	C	B	C		C	C
HUNGARY	C	C	C	C	C	C	C	C	C	C	C
HONG KONG	A	C	C	A	A		A	C	C	C	A
INDIA[e]	B	C	C	C	C	C	B	C	C	C	C
INDONESIA[e]	C	C	C		C	C		C		C	
IRELAND	B	C	B	B	B		B				
ISRAEL	C	C	C	C	C	C	C		C	C	C
ITALY	B	B	B	B	B	B	B	B		B	C
JAPAN	A	A	A		A	A	A	A	A	B	A
KOREA	B	B	C	C	B		B	B	C	C	B
LUXEMBURG	C	C	C	C	C			C			C
MALAYSIA[e]	B	B	B	B	B		B	C		C	C
MEXICO[e]	B	B	B	B	C		B				
NETHERLANDS	A	B	B	A	B		A	C	B	C	
NEW ZEALAND	C	C	C	C	C		C			C	C
NORWAY	B	C	C	C	C		B	C			B
PAKISTAN[e]	C	C	C		C	C	C	C		C	C
PHILIPPINES[e]	B		C	C	B	C	C	C		C	C
PERU[e]	C	C	C	C	C		C			C	C
POLAND[e]	C	C	C		C		C	C	C	C	
PORTUGAL	B	C	B	B	B	C	B		C	C	C
RUSSIA[e]	C			C	C			C		C	C
SINGAPORE	B	B	B	B	B	B	B	B	C	C	
SLOVENIA[e]	C					C					
SOUTH AFRICA[e]	A	A	C	B	B	C	A	B	B	C	
SPAIN	B	B	B	C	B	B	B	B	B	B	B
SRI LANKA[e]	C		C		C		C	C			
SWEDEN	B	B	B	B	B	C	B		B	C	
SWITZERLAND	B	B	B	B	B	B	B		B	C	B
TAIWAN[e]	B	B	C	C	C		B		C		
THAILAND[e]	B		B	C	B	C	C	C	C	C	C
TURKEY[e]	B	B	B	C	B		C	C	C		B
UK	A	A	A	A	A	A	A	A	C	B	B
US	A	A	A	A	A	A	A	A	A	A	A

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